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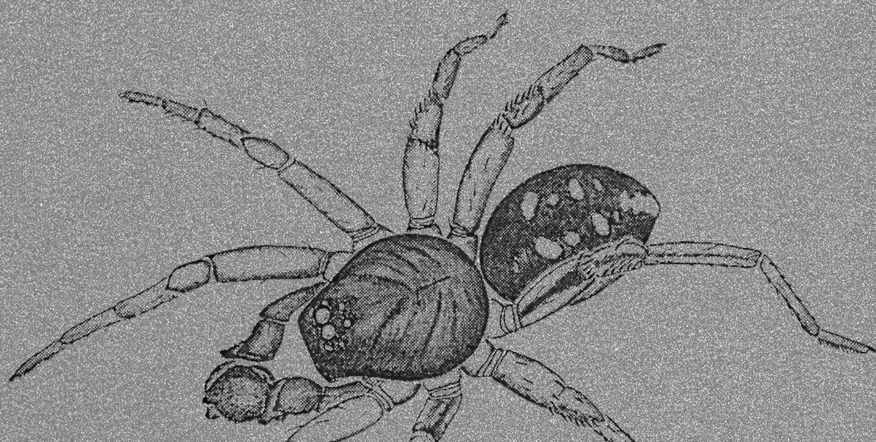

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Cover: This undescribed ant spider (Zodariidae), known only from the Expedition Range, is one of about 25 new *Habronestes* species from Queensland. In Australia, *Habronestes* is one of the most diverse genera of ant spiders with almost 130 species, of which only about one fifth are described. They are small to medium-sized spiders (2 – 12 mm in length) and most can be recognised by the bright yellow or orange spots on their backs and the distinctive palps of the males. Illustration by Barbara Baehr.

THE INSECT COMPLEX INHABITING GALLS FORMED BY *CECIDOMYIA ACACIAELONGIFOLIAE* SKUSE (DIPTERA: CECIDOMYIIDAE) ON BLACKWOOD (*ACACIA MELANOXYLON*) IN TASMANIA

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Abstract

Cecidomyia acaciaelongifoliae Skuse is newly recorded from Tasmania, where it forms galls on blackwood, *Acacia melanoxylon*, a new host record. Five species of Lepidoptera and four species of Hymenoptera were found to be associated with the galls.

Introduction

Blackwood, *Acacia melanoxylon* R. Br. (Mimosaceae), is a valued timber tree, endemic to eastern Australia and Tasmania and introduced to other countries such as South Africa and New Zealand. The timber is the basis of an important furniture and veneer industry in Tasmania and the expansion of the blackwood estate through plantation development has been an important development in adding value to Tasmania's forest industry. As a tree species it has few insect pests of significance to growth increment (Jennings 1991). In New Zealand, 18 species of insects have been recorded feeding on blackwood (Appleton and Walsh 1997).

Flower bud gall formation on blackwood has not been recorded previously from Tasmania (Bashford 2004), although *Trichilogaster acaciaelongifoliae* (Froggatt) (Hymenoptera: Pteromalidae) galls have been reported on blackwood in South Africa (Dennill *et al.* 1993). Froggatt (1923) described the wattle gall-fly, *Cecidomyia acaciaelongifoliae* Skuse, as being common on the foreshores of Sydney Harbour, NSW, on long-leafed wattles. McKeown (1942) reported *C. acaciaelongifoliae* attacking the flower buds of several *Acacia* species in New South Wales, causing a twisted mass of green tubes which later turned brown as they dried.

Materials and methods

Galls were initially collected in March 2000, from several blackwood trees growing in Lauriston Reserve near George Town in northern Tasmania. Both green (Fig. 1) and dried, brown galls were collected in January and February 2001. The galls were placed in paper bags and transferred to laboratories in Hobart the same day. The galls were then placed individually into plastic food containers with perforated lids to prevent condensation. The containers were placed in a controlled temperature room at 18°C and examined weekly for insect emergence. Single, galled blackwood trees were also detected in recreational parks at Burnie and Deloraine. All infested trees located were exposed trees in open situations. Routine surveys of blackwood plantations by Forest Health officers found no other evidence of galled plants.

Specimens of the cecidomyiid fly and hymenopteran parasitoids reared from the galls were sent to the Australian National Insect Collection in Canberra for identification.

Fig. 1. Developing galls on *Acacia melanoxylon* in Tasmania, caused by *Cecidomyia acaciaelongifoliae.*

Results

The ten insect species reared from the galls are listed in Table 1. Apart from *Cecidomyia acaciaelongifoliae*, five species of Lepidoptera and four species of Hymenoptera were recorded.

Discussion

Cecidomyia acaciaelongifoliae is newly recorded from Tasmania and *Acacia melanoxylon* is a new host record.

All Lepidoptera species emerging from the galls were recorded from other *Acacia* galls in previous studies (Bashford 2002, 2004). Of the four species of Hymenoptera recorded, the ichneumonid *Glabridorsum stokesii* (Cameron) is a common parasitoid of Lepidoptera larvae inhabiting galls in Tasmania. Platygasterids are mainly parasitoids of cecidomyiids (Masner 1993, J. LaSalle pers. comm.) and species of *Torymoides* Walker (Torymidae) are known mainly from dipteran galls, including those caused by cecidomyiids (J. LaSalle pers. comm.). Species of *Sierola* Cameron (Bethylidae) have been reared from other types of gall on *Acacia* species in Tasmania, usually associated with lepidopteran inquilines (Bashford 2004).

The large number and unusual structure of the galls found on the affected trees in Tasmania caused shoot dieback and reduced seed production markedly. Any biotic agent that has an impact on growth increment and form needs to be identified and its impact risk factored into growth models. The establishment of plantations off-site may result in an increase in biotic loads, especially if trees are under stress, and knowledge of insect pests and diseases is an important component in developing high quality sustainable timber products. Records of insect pests that have the potential to become a problem in a rapidly increasing blackwood plantation estate are of value in determining management decisions.

Table 1. Insect species reared from flower bud galls formed by *Cecidomyia acaciaelongifoliae* on *Acacia melanoxylon* in Tasmania.

Insect species	Family	Number of specimens
DIPTERA		
Cecidomyia acaciaelongifoliae Skuse	Cecidomyiidae	237
LEPIDOPTERA		
Erechthias mustacinella (Walker)	Tineidae	66
Opogona comptella (Walker)	Tineidae	3
Polysoma eumetalla (Meyrick)	Gracillariidae	6
Stathmopoda chalcotypa Meyrick	Oecophoridae	22
Macrobathra sp.	Cosmopterigidae	3
HYMENOPTERA		
Glabridorsum stokesii (Cameron)	Ichneumonidae	12
Sierola sp.	Bethylidae	32
Torymoides sp	Torymidae	154
Genus and species indet.	Platygasteridae	287

Acknowledgements

I thank Dr John LaSalle at the Australian National Insect Collection for his help in examining the Hymenoptera and Dr Don Colless for confirming the identification of the cecidomyiid gall former. I also thank Comalco Aluminium (Bell Bay) Limited for allowing access to trees in Lauriston Reserve.

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FIRST CONFIRMED OBSERVATION OF *HETERONYMPHA CORDACE WILSONI* BURNS (LEPIDOPTERA: NYMPHALIDAE: SATYRINAE) IN SOUTH AUSTRALIA

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Abstract

A population of *Heteronympha cordace wilsoni* Burns was discovered in South Australia east of Port MacDonnell in December 2004. Although it is unknown if the species is breeding at or near this site, due to the apparent lack of its host plant, this appears likely because of the extremely fresh condition of some of the specimens observed. *H. cordace wilsoni* was presumed extinct from various localities where it was once common and this is the first documented observation for over 27 years.

Introduction

The bright-eyed brown, *Heteronympha cordace* (Geyer), is a geographically variable satyrine with two subspecies found in southeastern Australia and three others restricted to Tasmania (Braby 2000). Subspecies *H. c. wilsoni* Burns has been recorded only from southwestern Victoria, from the Wannon River in the Grampians southwest to Dartmoor and Nelson (Braby 2000, Dunn *et al.* 1994, Sands and New 2002). It was suspected (but not confirmed) to occur in South Australia by Grund (1998).

Dunn *et al.* (1994) rated the conservation status of *H. c. wilsoni* as 'Vulnerable', Grund (1998) as 'Endangered' in South Australia and Sands and New (2002) as 'Critically Endangered' throughout its range. Previous reports and studies (Fisher 1978, Grund and Hunt 2000) failed to record and/or find this species in South Australia but Grund and Hunt (2000) suggested it could be present as suitable habitat occurs.

H. c. wilsoni occurs in swampy areas where its host plant *Carex appressa* is present (Grund and Hunt 2000, Sands and New 2002, Dunn *et al.* 1994). Adults are not known to fly far from sites where the larval food plant occurs and have a slow, meandering flight close to the ground among the larval food plants, unlike other species of *Heteronympha* Wallengren (Braby 2000).

H. c. wilsoni is smaller and paler than typical *H. c. cordace*, the orange markings on the upperside are paler and more extensive and the eyespots much smaller. The underside ground colour is paler, with the markings on the hind wing obscure and ill-defined. The eyespots on the underside are smaller or absent (Dunn *et al.* 1994, Braby 2000, Sands and New 2002).

First South Australian observations

Observers. Vicki Natt, Elaine Lawson, Jean Haywood and Bryan Haywood.

Locality. Between the South Australia/Victoria border and Port MacDonnell in the lower southeast of South Australia.

Habitat. Leptospermum lanigerum shrubland with *Phragmites australis*, *Myoporum insulare, Acacia longfolia var sophorae* and various species of Cyperaceae.

Observations. In mid to late afternoon on 30 December 2004, in fine, mild weather, V. Natt, E. Lawson and J. Haywood noticed three to four small, orange butterflies flitting around and feeding on creeping brookweed (*Samolus repens*) flowers that bordered the rushes. After being disturbed they did not fly far and usually alighted on or near another *Samolus* flower. They were similar in colouring to the common brown, *Heteronympha merope merope* (Fabricius), but smaller, with a much more distinctive black and orange pattern that was striking on the upperside of both fore and hind wings and on the underside of the forewing. The underside of the forewing had less distinct, more subdued pattern/colouring.

The individuals observed (Figs 1-2) had eyespots with blue centres on both fore and hind wings. On limited occasions we observed them open their wings, when we could see a very tiny eyespot at the top of the upperside of the hind wing. Several digital photographs were taken and these were enough to work from for an identification using Braby (2000).

Subsequent visits to the site in January 2005 by B. Haywood found that the butterfly was still flying and both sexes were present. On several occasions observations were made of a smaller and paler (presumed male) individual pursuing a larger (presumed female) individual throughout the site. The last visit to the site was on 24 January, with one male and one female observed.

Discussion

The individuals of *H. c. wilsoni* observed at the site were identical to those described in Braby (2000) and Dunn *et al.* (1994); however, there are a few additional features to report. A photograph of one specimen had one bluish-white spot above the subtornal eyespot on the underside of the hind wing. Also, minute white spots are evident between the two upperside hind wing eyespots, and one below the apical eyespot on the forewing. Specimens photographed in the field showed much variation in these markings and they were not always present. Further taxonomic investigations are warranted on this population.

Drainage, wildfire and cattle grazing have been identified as threatening processes against the long-term survival of this species. In South Australia, these *Carex* swamp habitats are now severely degraded and fragmented (Grund and Hunt 2000). Alterations to hydrology in potential habitat areas should be closely scrutinised before permission to alter these areas is granted. Sands and New (2002) highlighted the poor dispersal ability of this butterfly, rendering isolated populations susceptible to extinction from habitat loss or degradation. This fact highlights the importance of connectivity between colonies, as natural re-colonisation is unlikely in a fragmented landscape.

Figs 1-2. *Heteronympha cordace wilsoni* in South Australia. (1) perched on reed; (2) basking.

Braby (2000), Grund and Hunt (2000) and Grund (1998) all noted that this species flies close to the ground amongst the larval food plant. *Carex appressa* was not observed where the butterflies were flying, so this is inconsistent with our observations. Further surveys should be undertaken in South Australia and Victoria to ascertain whether past populations are still extant, whether new populations can be found, and if they are using a different host plant.

Acknowledgements

We thank Jan Forrest (South Australian Museum, Adelaide) for information on specimens held in the Museum, Dianne Smith (DEH Library, Canberra) for assistance in accessing reference material, and Lucy Brindley and Luke Campbell for providing additional photographs for analysis. Fabian Douglas and Roger Grund are especially thanked for their input, interest and enthusiasm towards this finding and future work on this species.

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BUTTERFLY (LEPIDOPTERA) RECORDS FROM THE DARWIN REGION, NORTHERN TERRITORY

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Abstract

From 1990 to 2005, 87 of the 111 butterfly species recorded from Darwin in the Northern Territory were reared or collected by the authors from within a 15 km radius of the city centre. Details of localities and months of capture are provided, together with notes on the additional 24 recorded species not collected during the survey.

Introduction

The remoteness of Darwin, in the 'Top End' of the Northern Territory in Australia, is the principal reason why only a small number of butterfly workers visited the region in the past. Early butterfly workers, such as F.P. Dodd in 1908 and 1909, had to endure long sea journeys (Monteith 1991) and, on arrival, were faced with limited access to potential collecting areas. Much of the early collecting was restricted to the local Port Darwin area or from sites such as Rum Jungle, Adelaide River, Brocks Creek and Pine Creek, all sidings along the rail line south from Port Darwin, as road access was limited. In recent years, improvements in road conditions and readily accessible air travel has seen more butterfly workers visiting Darwin yet, to the best of our knowledge, no checklist of butterflies for the Darwin region has ever been published.

For the purposes of this paper, the Darwin 'region' is defined as the area within a 15 km radius of the city centre. Collecting localities are mapped in Figure 1 and listed, together with habitat data, in Table 1. Over the past 15 years we have recorded 87 butterfly species from the Darwin region. These records are listed in Table 2, along with locality and months of capture or emergence. Literature records for a further 24 species from Darwin are reviewed and discussed, all of which require further data to confirm their existence in the Darwin region.

We follow the scientific nomenclature of Common and Waterhouse (1981) in order to maintain consistency with the International Code of Zoological Nomenclature, and have retained historical subspecies names except where a taxonomic revision of a species or subspecies has been published.

Darwin plant habitats

Brock (1993) described three broad categories of habitat, showing a natural progression from sandstone through lowland to coastal plant communities. The Darwin region consists of lowland to coastal plant communities, although on Channel Island a remnant sandstone plant community exists, supporting *Baronia lanceolata* (Rutaceae), a food plant for *Nesolycaena*

urumelia (Tindale) (Edwards 1980, Meyer 1996b). Brock (1993) further subdivided these lowland and coastal habitats into plant communities associated with open forest or woodland, monsoon vine forests, swamps and mangroves. We follow Brock's descriptions for the data provided in Table 1, except that an additional habitat of parkland has been added to cover parks and reserve areas in suburban Darwin, where council plantings of *Pongamia pinnata* (Fabaceae), *Calophyllum inophyllum* (Clusiaceae) and host trees supporting the mistletoe *Decaisnina signata* (Loranthaceae) can be readily found.

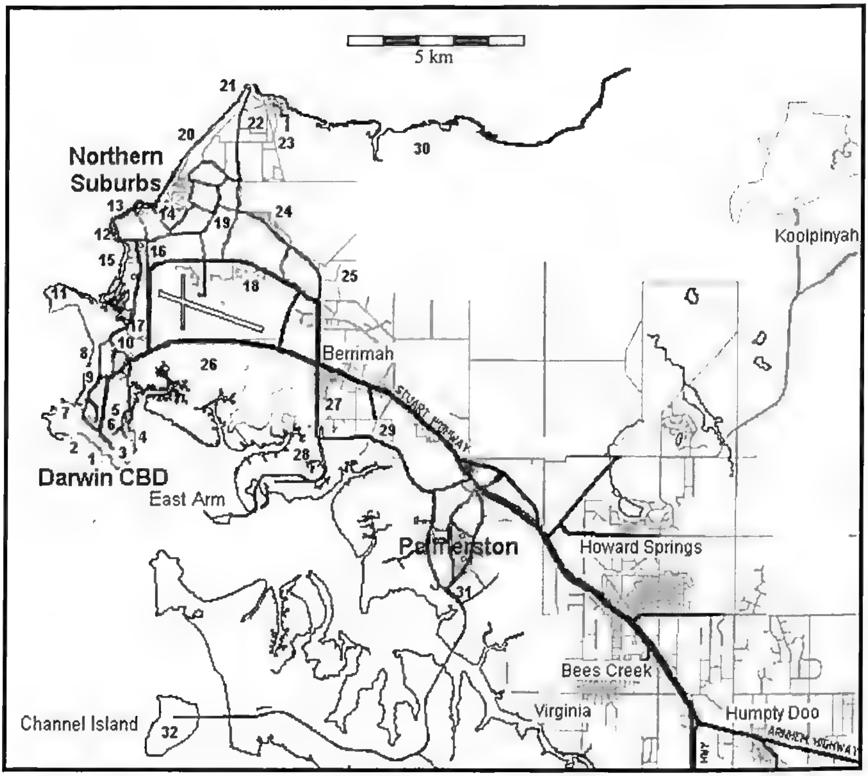

Fig. 1. Map of collecting localities in the Darwin region. (Based on a map taken from *http://uluru.nt.gov.au/prod/bams/inventory/index.cfm?fuseaction=inventory&hreflink =D11*)

Table 1. Key to butterfly locality and habitat data for sites shown in Fig. 1. The letters under the Habitat heading refer to the following plant community keys: Open Woodland (O); Monsoon Vine Forest (V); Swamp (S); Mangroves (M); Parkland (P).

Locality		Habitat	Locality		Habitat
1	Darwin Esplanade	P,V	17	Bagot Reserve	P
2	Doctors Gully	P	18	Darwin Golf Club	P
3	Administrators Hill	P	19	Wagaman	P
4	Francis Bay	P	20	Casuarina Beach	P
5	Stuart Park Jungle	V	21	Lee Point	V
6	Stuart Park Primary School	P	22	Buffalo Creek off Lee Point Road	V,O
7	Myilly Point	P	23	Buffalo Creek Jungle	V,M,S
8	Fannie Bay	P	24	Leanyer	P
9	Darwin High School	P	25	Holmes Jungle	V
10	Parap	P	26	Winnellie	O
11	East Point Reserve	V	27	Berrimah	O
12	Nightcliff Beach	V	28	Bens Hill, Trade Development Zone	O
13	Nightcliff Esplanade	P	29	Thorak Road	O
14	Rapid Creek	P	30	Shoal Bay	V,M,S,O
15	Coconut Grove	P	31	Palmerston	P
16	Velodrome, McMillians Road	P	32	Channel Island via Palmerston	V,M,O

Table 2. Darwin butterflies collected or reared by the authors from 1990-2005.

Species	**Localities (see Table 1)**	**J**	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
		Months collected / emerged											
HESPERIIDAE													
Hasora chromus chromus (Cramer)	7,13,14,22,30		x			x				x	x	x	x
Hasora hurama hurama (Butler)	22			x	x								
Badamia exclamationis (Fabricius)	11,21,22,27,30	x	x								x		x
Chaetocneme denitza (Hewitson)	31			x						x			
Neohesperilla xiphiphora (Lower)	28	x	x	x									
Neohesperilla crocea (Miskin)	27,29							x				x	
Neohesperilla senta (Miskin)	27	x	x										
Hesperilla sexguttata Herrich-Schäffer	22,23,30	x	x	x	x								
Taractrocera anisomorpha (Lower)	29			x									
Taractrocera dolon diomedes Waterhouse	1,3				x					x			
Taractrocera ina Waterhouse	1,2,5,6,22,29,31	x	x										x
Ocybadistes flavovittatus vesta (Waterhouse)	31									x			
Ocybadistes walkeri olivia Waterhouse	1,5,22,29,31	x	x			x	x					x	x
Ocybadistes hypomeloma vaga (Waterhouse)	5,27		x			x					x	x	
Suniana lascivia larrakia Couchman	1,3,5,6,29	x	x		x					x		x	x

Species	Localities	Months collected / emerged											
	(see Table 1)	J	F	M	A	M	J	J	A	S	O	N	D
Suniana sunias sauda Waterhouse	1,5,27	x	x										x
Telicota colon argeus (Plötz)	5,21,29,31		x	x	x								
Telicota augias argilus Waterhouse	5,11,20,21,22, 29,30,32		x	x	x								
Cephrenes trichopepla (Lower)	17,22,26,28,30, 31	x	x	x	x	x			x			x	x
Cephrenes augiades (C. Felder) ssp.	5,11		x	x	x	x	x						
Parnara amalia (Semper)	11,22,23,27,28	x	x		x								x
Borbo impar lavinia (Waterhouse)	5,6,22,31	x	x		x	x	x					x	x
Pelopidas lyelli lyelli (Rothschild)	5,6,11,21,22,27	x	x	x	x	x						x	x
PAPILIONIDAE													
Graphium eurypylus nyctimus (Waterhouse & Lyell)	1,5,11,20,21,22, 32	x	x	x						x		x	
Papilio fuscus canopus Westwood	5,11,20,21,22, 23,30,31,32		x		x			x				x	x
Papilio demoleus sthenelus W.S. Macleay	4,11,20,30,31		x				x	x					
Cressida cressida cassandra (Waterhouse & Lyell)	11,21,26,27,28, 30,31,32		x	x	x	x							
PIERIDAE													
Catopsilia pomona pomona (Fabricius)	7,11,14,20,21, 22,30,31,32	x	x	x	x	x							x
Catopsilia scylla etesia (Hewitson)	1,11,31			x	x	x							
Eurema hecabe hecabe (Linnaeus)	1,10,11,28,30, 31,32		x	x		x				x		x	
Eurema alitha (C. & R. Felder)	11,28,32	x	x	x		x							
Eurema lạeta sana (Butler)	21,30	x	x										x
Elodina walkeri Butler	1,11,20,21,22, 30,32	x	x			x	x		x			x	
Delias argenthona fragalactea (Butler)	6,8,9,10,13,14, 15,16,28,31	x							x	x			
Delias mysis aestiva Butler	5,23,27			x	x	x					x		
Belenois java teutonia (Fabricius)	30									x			
Cepora perimale scyllara (W.S. Macleay)	11,21,22,30		x			x							
Appias paulina ega (Boisduval)	11,21,22,30	x	x	x	x	x							
NYMPHALIDAE													
Danaus petilia (Stoll)	11,21,22,23,30, 31,32	x			x		x						
Danaus affinis affinis (Fabricius)	11,21,22,23,30, 31,32				x	x	x						
Tirumala hamata hamata (W.S. Macleay)	6,30	x	x										
Euploea core corinna (W.S. Macleay)	11,20,22,23,30, 31,32		x	x	x	x							
Euploea sylvester pelor Doubleday	11,21,30,32		x	x		x							

Species	**Localities (see Table 1)**	**Months collected / emerged**											
		J	**F**	**M**	**A**	**M**	**J**	**J**	**A**	**S**	**O**	**N**	**D**
Euploea darchia darchia (W.S. Macleay)	5,11,21,22,23, 30		x		x	x							
Melanitis leda bankia (Fabricius)	1,5,6		x			x	x						
Mycalesis sirius sirius (Fabricius)	1					x							
Mycalesis perseus perseus (Fabricius)	11,22,23			x	x	x							
Hypocysta adiante antirius Butler	5,19,29		x	x									x
Ypthima arctous arctous (Fabricius)	29,30			x									x
Polyura sempronius sempronius (Fabricius)	1,27,28		x							x			
Hypolimnas bolina nerina (Fabricius)	1,11,20,21,22, 27,30,31,32		x	x	x	x			x				
Hypolimnas misippus (Linnaeus)	20,21,27,30	x		x	x		x						
Hypolimnas alimena darwinensis Waterhouse & Lyell1	1,11,22,30		x	x	x	x							
Junonia hedonia zelima (Fabricius)	11,30		x	x	x	x							
Junonia villida calybe (Godart)	11,30,31		x										x
Junonia orithya albicincta Butler	11,30,31	x	x		x		x			x			
Cethosia penthesilea paksha Fruhstorfer	11,30,32			x	x	x							
Phalanta phalantha araca (Waterhouse & Lyell)	11,21,22,27,31	x	x	x	x	x							
Acraea andromacha andromacha (Fabricius)	11,28,32		x			x	x						
Libythea geoffroy genia Waterhouse	31		x										
LYCAENIDAE													
Liphyra brassolis major Rothschild	6,18,27,31	x			x		x					x	
Hypochrysops ignitus erythrinus (Waterhouse & Lyell)	27,28		x		x								x
Hypochrysops apelles apelles (Fabricius)	23,32		x	x	x	x	x	x		x		x	
Arhopala centaurus asopus Waterhouse & Lyell	28	x		x								x	x
Arhopala micale amydon Waterhouse	8,10,11,13,14	x			x							x	x
Ogyris zosine typhon Waterhouse & Lyell	9,16	x	x						x		x	x	x
Ogyris amaryllis hewitsoni (Waterhouse)	12,32	x	x	x			x	x	x	x	x	x	x
Hypolycaena phorbas ingura Tindale	1,20,21,28,30, 32	x			x	x	x	x	x				x
Deudorix smilis dalyensis (Le Souëf & Tindale)	11,21,22,23					x	x	x	x				
Anthene seltuttus affinis (Waterhouse & R.E. Turner)	1,10,13						x	x	x	x			
Anthene lycaenoides godeffroyi (Semper)	1,5,11,20,22,23, 32					x	x	x		x	x		
Candalides gilberti Waterhouse	1,6,8,9,10,13, 14,16,31	x	x	x	x	x	x	x	x	x	x	x	x
Candalides erinus erinus (Fabricius)	21,28,29,30		x									x	
Nesolycaena urumelia (Tindale)	32	x	x	x	x		x			x			

Species	Localities (see Table 1)	J	F	M	A	M	J	J	A	S	O	N	D
Prosotas dubiosa dubiosa (Semper)	11,30,32			x	x	x						x	x
Catopyrops florinda estrella (Waterhouse & Lyell)	1,11				x	x				x			
Theclinisthes miskini miskini (T.P. Lucas)	11,18,26,29,30	x	x	x	x							x	
Theclinisthes sulpitius (Miskin)	24,30	x			x		x						x
Jamides phaseli (Mathew)	13									x	x		
Catochrysops panormus platissa (Herrich-Schäffer)	18,30		x										
Lampides boeticus (Linnaeus)	27												x
Zizeeria karsandra (Moore)	22,30		x	x								x	x
Zizina labradus labradus (Godart)	28		x										
Famegana alsulus alsulus (Herrich-Schäffer)	21,30		x		x								
Zizula hylax attenuata (T.P. Lucas)	5							x				x	x
Euchrysops cnejus cnidus Waterhouse & Lyell	1,11				x	x							
Freyeria putli putli (Kollar)	27		x										

Additional literature records

HESPERIIDAE

Proeidosa polysema (Lower)

Lower (1911) first recorded this species (as *Anisynta polysema*) from Port Darwin, based on a single male collected by F.P. Dodd in February 1909. Dodd and his son Walter were based in Port Darwin for 10 months from August 1908, exploring the East Point rainforest north to Rapid Creek (Monteith 1991). Waterhouse and Lyell (1914) recorded the holotype female from Petford near Chillagoe, Queensland, taken in February, and two males from Port Darwin. They incorrectly listed January, February and March as the months of capture for the two Port Darwin males. Waterhouse (1933) recorded an allotype male from Port Darwin, collected in February 1909, in the South Australian Museum, Adelaide, a paratype male from Port Darwin, collected in February 1909, in the Australian Museum, Sydney and other males from Port Darwin, collected in January and March, plus a female collected in April. Subsequent authors (Common and Waterhouse 1972, 1981, Dunn and Dunn 1991, Braby 2000) have continued to refer to the Port Darwin records in the distribution of this butterfly in the Northern Territory.

The larvae of this species feed on *Triodia* spp. (Poaceae), generally found growing on rocky sandstone outcrops and slopes. *Triodia* records for the Darwin region are sketchy but there have been records from Casuarina Beach (Darwin Herbarium). It is not known whether the *Triodia* was of the coastal dunes variety or those found in the more arid regions. We have collected this butterfly from the sandstone escarpment country behind a radio repeater

station, 15 km south of the Adelaide River township, along the old Stuart Highway. Further data are required to determine whether it exists in the Darwin region. We believe it is unlikely that it will be encountered there in the future, due to a lack of suitable habitat.

Taractrocera ilia ilia Waterhouse

Waterhouse (1932a) described this species (as *Taractrocera udraka ilia*) from four males and two females from the King River, one male from Port Darwin in the South Australian Museum and a female from Melville Island. Waterhouse (1932a) noted that the Port Darwin specimen was collected in November and bore a label in Lower's handwriting '*T. flavogattata* Plötz male'. Waterhouse (1932b), Common and Waterhouse (1972, 1981), Dunn and Dunn (1991) and Braby (2000) all listed Darwin in the distribution of this butterfly. We are not aware of any records of this butterfly from Darwin other than the original male referred to by Waterhouse (1932a). Most records for this butterfly appear to be from the King River eastwards into Arnhem Land and we have found it to be common locally at Little Nourlangie Rock, Kakadu National Park. Further data are required to determine whether it exists in the Darwin region. We believe it is unlikely that it will be encountered there in the future, due to a lack of suitable habitat.

Oriens augustulus (Herrich-Schäffer)

Evans (1949) recorded a single male, labelled Port Darwin, in The Natural History Museum (BMNH), London. This butterfly is native to Fiji. Common and Waterhouse (1981) questioned the natural occurrence of the butterfly in Australia and Braby (2000) noted that it might have been introduced accidentally, as there are no recent records to support its establishment in Australia. Edwards *et al.* (2001) stated 'it was probably not permanently established in Australia'. Further data are required to determine whether it exists in the Darwin region. We believe it is unlikely that it will be encountered there in the future and is probably a locality label error.

Telicota ancilla baudina Evans

Lower (1911) recorded this species from Sydney to Port Darwin. Evans (1949) included three males and one female from Port Darwin in his description of the subspecies. Braby (2000) noted that a female collected by Dunn in 1979, from Lameroo Beach (Dunn and Dunn 1991), is actually *Telicota augias* (Linnaeus). We are unaware of any further records of this butterfly from Darwin. In July 2004, we found three larvae of what we believe to be this butterfly feeding on *Imperata* sp. (Poaceae), a known food plant, at Robin Falls on the old highway south of the Adelaide River township. Unfortunately, we were unsuccessful in rearing them to adults. The larvae closely resembled those *T. ancilla ancilla* (Herrich-Schäffer) from the east coast. Further data are required to confirm its existence in the Darwin region.

Telicota mesoptis mesoptis Lower

Peters (1969) recorded a single male, labelled Port Darwin, NT, 24.xi.1902, G. Turner, in the Australian Museum, Sydney. This is the only known record of this butterfly from the Northern Territory and Braby (2000) noted that further surveys were required to determine whether it exists in the Northern Territory. We believe it is unlikely that it will be encountered in the Darwin region in the future and is probably a locality label error.

Borbo cinnara (Wallace)

Angel (1951) first recorded collecting specimens of this butterfly at Adelaide River, Darwin and Berry Springs, where it was supposedly more plentiful than *Borbo impar lavinia*, during a collecting trip that he and F.E. Parsons undertook during April and May 1948. Couchman (1951) provided comments on the specimens collected by Angel and Parsons during this trip and noted that a single male had been collected at Darwin on 7 May 1948. Dunn and Dunn (1991) incorrectly referred the Darwin record to Couchman, assigning only the Adelaide River records to Angel. Braby (2000) assigned all records to Angel and noted that very few records were known. Braby (2000) suggested that the butterfly may have been overlooked because of its superficial resemblance to the more common *Pelopidas* Walker species. Further data are required to confirm its existence in the Darwin region.

Pseudoborbo bevani (Moore)

Waterhouse (1932a) first recorded this species from Australia (as *Baoris bevani*) based on three undated specimens in the South Australian Museum, labelled Port Darwin. These three specimens are the only records from Australia (Braby 2000). Waterhouse (1932a, 1937) believed the species may have been introduced, as its larvae feed on rice. Experimental rice crops have been grown in the Darwin region from as early as 1879 and, more recently, Territory Rice Ltd operated on the Adelaide River flood plains from 1952 to 1960, when operations were abandoned (Powell 2000). Systematic searching over the years by the present authors around the old Adelaide River rice project areas at Tortilla Flats, Harrison Dam and Fogg Dam failed to turn up any specimens. Further data are required to determine whether it exists in the Darwin region.

Pelopidas agna dingo Evans

Angel (1951) recorded specimens from Darwin and Berry Springs during the first week of May 1948 and noted that it was only seen occasionally. Couchman (1951) provided comments on the specimens collected by Angel and Parsons during this trip and noted that the single male collected by them on 7 May 1948 was the first to be recorded from Darwin. Dunn and Dunn (1991) recorded specimens in the Museum of Victoria, Melbourne and the Australian National Insect Collection (ANIC), Canberra; however, they noted that most records were based on females. A female collected by E.D. Edwards from Holmes Jungle on 15 May 1973, in the ANIC, would appear to

be this species since it agrees with the description provided by Braby (2000) on how to separate females of *P. lyelli lyelli* from those of *P. agna dingo*. We have numerous females of *Pelopidas* spp. and many are difficult to separate. Further data are required to confirm its existence in the Darwin region.

PAPILIONIDAE

Papilio aegeus aegeus Donovan

Dunn and Dunn (1991) first recorded this species from Darwin based on a specimen in the J.T. St Leger Moss collection and they were followed by Braby (2000). The Darwin record is probably the result of the nursery trade, as it would appear that the butterfly has not established itself in Darwin despite the abundance of citrus host plants. Further data are required to determine whether it still exists in the Darwin region.

PIERIDAE

Catopsila pyranthe crokera (W.S. Macleay)

Braby (2000) attributed the Darwin record for this species to T.L. Fenner; however, this record is in error (T.L. Fenner pers. comm.). Adults may be encountered in Darwin in the future during irregular seasonal migrations but little is known of the butterfly's behaviour in the northern areas of its distribution (Braby 2000). Further data are required to determine whether it currently exists in the Darwin region.

Eurema brigitta australis (Wallace)

Waterhouse and Lyell (1914) first recorded this species (as *Terias libythea zoraide* Felder) from Darwin, with specimens collected in February and March (presumed to be F.P. Dodd specimens). Dunn and Dunn (1991) noted no other records and Braby (2000) also made reference to Darwin within the butterfly's distribution. Further data are required to confirm its existence in the Darwin region.

Eurema smilax smilax (Donovan)

Waterhouse and Lyell (1914) first recorded this species (as *Terias smilax*) from Darwin, with specimens collected in March. Subsequent authors (Common and Waterhouse 1972, 1981, Dunn and Dunn 1991, Braby 2000) all detailed an Australia-wide distribution, although none specifically referred to Darwin. There is a single male in the ANIC, Canberra, from Darwin collected on 5 May 1948, originally from the F.E. Parsons collection. The butterfly is known to be an opportunistic migrant (Braby 2000) and it might be encountered in the Darwin region in the future; however, further data are required to determine whether it currently exists there.

Eurema herla (W.S. Macleay)

Peters (1969) first recorded this species from Port Darwin from four males and two females dated 16.ii.-19.iii.1909, plus three undated males all collected by F.P. Dodd. These specimens are in the Australian Museum,

Sydney. We have collected this butterfly from Marrakai Road, approximately 70 km south of Darwin. Further data are required to confirm its existence in the Darwin region.

Appias albina albina (Boisduval)

Waterhouse and Lyell (1914) first recorded this species from Darwin in March. Subsequent authors (Waterhouse 1932b, Common and Waterhouse 1972, 1981, Dunn and Dunn 1991, Braby 2000) all included Darwin within the butterfly's distribution. There is a single female in the ANIC, Canberra, collected in January 1977 by Gary Fitt. Recently, a single male was collected from East Point Reserve on 3 March 2000 (C.G. Miller pers. comm.), flying with *Appias paulina ega* and *Cepora perimale scyllara*. Braby (2000) suggested that populations of this butterfly may be resident in Darwin but further data are required to determine whether or not this is the case.

NYMPHALIDAE

Danaus genutia alexis (Waterhouse & Lyell)

Waterhouse and Lyell (1914) first recorded this species from Derby, Western Australia and Darwin (as *Danaida plexippus alexis*) from four males and three females. The Darwin specimens were collected in January and February (presumed to be F.P. Dodd specimens). Subsequent authors (Waterhouse 1932b, Common and Waterhouse 1972, 1981, Dunn and Dunn 1991, Braby 2000) also list Darwin in the distribution of this butterfly. We have collected it from Fog Bay on the Cox Peninsula and from Oolloo Crossing on the Daly River, where adults have been observed using the river as a flight corridor and pausing to feed at flowers along the river bank (Meyer 1995). Further data are required to confirm its existence in the Darwin region.

Hypolimnas anomala albula (Wallace)

Waterhouse and Lyell (1914) first recorded this species (as *H. antilope albula*) from Darwin from a single male collected in March. Subsequent authors (Waterhouse 1932b, Common and Waterhouse 1972, 1981, Dunn and Dunn 1991, Braby 2000) also referred to this record. Dunn and Dunn (1991) recorded three specimens from the Arnhem phytogeographic region in March. Braby (2000) noted that that the original specimen was taken in 1909, probably by F.P. Dodd, although Braby (2000) did not mention the collector. Braby (2000) also recorded another male collected by C.G. Miller at East Point Reserve on 10 February 1987, flying around a track through the vine forest (C.G. Miller pers. comm.). Further data are required to confirm its existence within the Darwin region.

Yoma sabina parva (Butler)

Waterhouse and Lyell (1914) first recorded this species from Darwin in March, probably collected by F.P. Dodd in 1909. We are unaware of any further records of this butterfly from Darwin and further data are required to confirm its existence in the Darwin region.

LYCAENIDAE

Ogyris iphis doddi (Waterhouse & Lyell)

Waterhouse and Lyell (1914) first recorded this species from Darwin from two males and two females, collected in September and November, presumably by F.P. Dodd in 1908. Dunn and Dunn (1991) recorded seven specimens from the Arnhem phytogeographic region taken in September, November and February (presumed also to be the original F.P. Dodd specimens). Braby (2000) noted that the butterfly had not been collected from Darwin since 1909, although an adult resembling this species was observed hill-topping in March 1992 on Bens Hill behind the Trade Development Zone (S.S. Brown pers. comm.). The last known record from the Northern Territory is a single female, taken at light (E.D. Edwards pers. comm.) during Operation Raleigh, from Pularumpi, Melville Island (11°4'S, 130°25'E) on 30 June 1986. The specimen is in the Northern Territory Museum collection and Braby (2000) attributed this record to P. Homer [actually P. Horner]. Despite extensive searching, we have not located any breeding colonies. Further data are required to confirm its existence in the Darwin region.

Deudorix diovis Hewitson

Dunn and Dunn (1991) first recorded this butterfly from Darwin from a single undated female collected by W. Graham. Braby (2000) also referred to the Dunn and Dunn (1991) record. The specimen was a female collected on the Darwin esplanade, flying in the company of *Hypolycaena phorbas ingura* on 25 May 1983 (W. Graham pers. comm.). It is probable that this butterfly occurs naturally in Darwin but has been overlooked in the past, as one of the known food plants, *Cupaniopsis anarcardioides* (Sapindaceae), grows prevalently along the esplanade. Further data are required to confirm its existence in the Darwin region.

Nacaduba kurava felsina Waterhouse & Lyell

Waterhouse and Lyell (1914) first recorded this species from Port Darwin (as *Nacaduba perusia felsina*) from three males and five females, collected in January, February, September and November (presumed to be the original F.P. Dodd specimens). Dunn and Dunn (1991) also included Darwin in the butterfly's records, based on specimens in the Museum of Victoria. We are unaware of any recent records from Darwin; however, it is quite possible that suitable habitat supporting the food plant *Embelia curvinervia* (Myrsinaceae) (Meyer 1996a, 1996b) still exists. We have collected and reared this butterfly from Marrakai Road, approximately 70 km south of Darwin, from Oolloo Crossing on the Daly River and from adjacent to the Adelaide River bridge on the Daly River Road. Further data are required to confirm its existence in the Darwin region.

Nacaduba biocellata biocellata (C. & R. Felder)

Common and Waterhouse (1981) first recorded this species from Darwin, attributing the record to K.L. Dunn. Dunn and Dunn (1991) and Braby (2000)

did not specifically list Darwin but gave an Australia-wide distribution for the butterfly. Further data are required to confirm its existence in the Darwin region.

Theclinesthes onycha capricornia Sibatani & Grund

Waterhouse and Lyell (1914) first recorded this species from Darwin (as *Theclinesthes onycha onycha* Hewitson) from specimens collected in August, September and October. Sibatani and Grund (1978) determined that in fact only one male from Port Darwin, collected by F.P. Dodd, belonged to this species, with the remaining records belonging to *T. miskini miskini* (T.P. Lucas). Common and Waterhouse (1981), Dunn and Dunn (1991) and Braby (2000) all referred to this single record. Larvae of this butterfly feed on the soft new growth of *Cycas* sp. (Cycadaceae) and *Macrozamia* sp. (Zamiaceae) (Braby 2000). *Cycas armstrongii* and *Cycas calcicola* both occur in the Darwin region (Brock 1993) and may prove to be the food plant near Darwin. Further data are required to confirm its existence in the Darwin region.

Sahulana scintillata (T.P. Lucas)

Waterhouse and Lyell (1914) first recorded this species from Darwin (as *Theclinesthes scintillata* Lucas) from specimens collected in September. Dunn and Dunn (1991) also recorded it from Darwin in September, based on two specimens in the Museum of Victoria, Melbourne (assumed to be original F.P. Dodd specimens), and noted that the underside markings of the females from Darwin are more contrasting than in females from Queensland or New South Wales. On 16 June 2003, four specimens were collected flying around the tops of trees adjacent to mangroves at Buffalo Creek (12.352S, 130.035E) (S.J. Johnson pers. comm.). It has also been collected at *Melaleuca* sp. (Myrtaceae) blossom in reasonable numbers from the Hunting Reserve, 10 km east of the Adelaide River bridge, and from adjacent to the Mary River bridge, both on the Arnhem Highway, in June 1994 by R. Stoodley, T. Woodger and J. O'Dell (R. Stoodley pers. comm.). Further data are required to confirm its existence in the Darwin region.

Everes lacturnus australis Couchman

Nowhere in the literature is this butterfly specifically recorded from Darwin, although the distribution maps contained in Common and Waterhouse (1972, 1981) and Braby (2000) encompass Darwin. We are not aware of any current or previous records of this butterfly from the Darwin region. We have collected it from Marrakai Road, approximately 70 km south of Darwin. Further data are required to confirm its existence in the Darwin region.

Summary

One hundred and eleven butterfly species have been recorded from the Darwin region to date, representing approximately 25% of Australia's known butterfly species. The present authors have recorded 87 of the 111 recorded species from the Darwin region since 1990. We believe it is unlikely that

Proeidosa polysema and *Taractrocera ilia* will be encountered in the Darwin region in the future, due to loss of suitable habitat. We also believe that the records of *Oriens augustulus* and *Telicota mesoptis mesoptis* are probably the result of incorrect labelling by their collectors. Further data are required to confirm the existence of the remaining 20 species recorded previously in the literature. In time, some of these records may also prove to be labelling errors, as some of the early butterfly workers, including F.P. Dodd, have been known to err with their label data. It is hoped that the data presented in this paper will help stimulate future butterfly workers in determining the existence or otherwise of the remaining 20 species in the Darwin region.

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RE-COLLECTION AND TENTATIVE HOST RECORD FOR *HYGIA (AUSTRALOCOLPURA) SANDARACINE* BRAILOVSKY (HEMIPTERA: COREIDAE: COLPURINI)

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Abstract

A second collection at the original type locality of the rare Australian colpurine coreid *Hygia (Australocolpura) sandaracine* Brailovsky is recorded, with an apparent feeding record on the tree fern *Dicksonia antarctica* Labill. (Dicksoniaceae).

Introduction

The coreid tribe Colpurini contains 21 species in Australia (Brailovsky 2001, Cassis and Gross 2002). Little is recorded of their biology although Brailovsky (1993) described them as 'typically species of the rainforest'. Collection records indicate that most colpurines are taken on the ground and among leaf litter. The only references to their food plants in Australia are those by Kumar (1966), who recorded *Pachycolpura manca* Breddin on *Urtica*, *Coreopsis*, tomato and pumpkin, and Steinbauer and Clarke (1996), who noted a possible association between *Acantholybas kirkaldyi* Bergroth and *Eucalyptus*. In New Zealand, the introduced Australian species *Acantholybas brunneus* (Breddin) feeds on a wide variety of plants, summarised by Steinbauer and Clarke (1996). Extralimital host records on cacao and taro in New Guinea for the Australian species *Agathyrna praecellens* Stål were summarised by Cassis and Gross (2002).

Hygia (Australocolpura) sandaracine Brailovsky was described from a single collection of two specimens in New England National Park, northern New South Wales (Brailovsky 1993). This paper documents a re-collection of the species and a possible food plant.

Observations

On January 1, 2004, a group of 10-15 individuals (including 3 pairs *in cop.*) and 5-10 nymphs (of early to late instar) of *H. sandaracine* were observed on fronds of the soft tree fern *Dicksonia antarctica* Labill. (Dicksoniaceae), on the Lyrebird Walk in New England National Park. At this point the track passes through 'myrtle forest' (temperate rainforest with *Nothofagus cunninghamii* (Hook.) Oerst.) at about 1300-1400 m altitude at the base of the eastern escarpment cliffs. A few individuals were observed with their rostra touching the central leader of the frond, apparently feeding. Five males and two females (Fig. 1) were collected for identification and have been deposited in the Australian National Insect Collection (ANIC), Canberra.

When handled, they released a pungent, ester-smelling odour, similar to that of other coreids (Steinbauer and Davies 1995).

Discussion

Records of heteropterans feeding on ferns are rare. The only member of the Pentatomomorpha recorded in Australia on ferns, in the summary by Cassis and Gross (2002), is the highly polyphagous rhyparochromid *Remaudiereana inornata* (Walker). Only gymnosperms and angiosperms were listed for world Coreidae (including only one Colpurini) by Schaefer and Mitchell (1983). No lower vascular plants were listed for Coreidae in a review of economically important species (Mitchell 2000). Schaefer (1965) regarded the Colpurini as 'primitive' within the Coreidae. If *H. sandaracine* can be shown to be monophagous on ferns it would support this view. However, this may be unlikely in view of the wide range of plants used by *Acantholybas brunneus* in New Zealand (see above). Clearly, more information on the host plants of native Australian Coreidae is required.

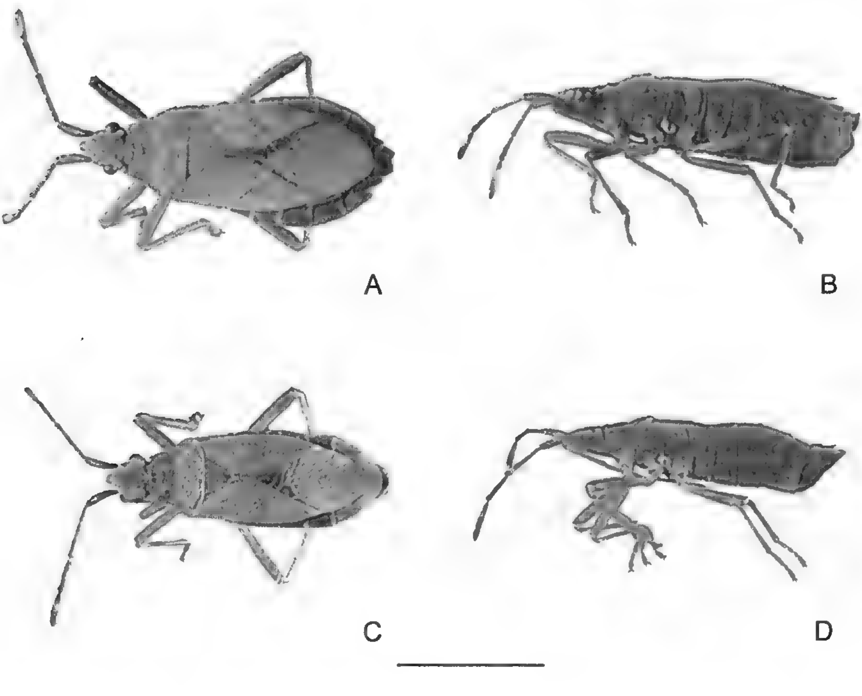

Fig. 1. *Hygia (Australocolpura) sandaracine* Brailovsky. (A-B) dorsal and lateral views of adult female, (C-D) dorsal and lateral views of adult male. Scale bar = 5 mm.

Acknowledgements

I thank Ben Boyd (ANIC, Canberra) for Fig. 1, Tony Prior (NSW National Parks and Wildlife Service, Dorrigo) for assistance in determining the identity of the host plant, Tom Weir (ANIC, Canberra) for confirmation of the initial species determination and an anonymous reviewer for beneficial revisions to the text.

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BIRNA, A NEW NAME FOR *LINEA* McDONALD (HEMIPTERA: PENTATOMIDAE)

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Abstract

Birna nom. n. is proposed as a replacement name for the genus *Linea* McDonald, 2003, preoccupied by *Linea* Schroder, Medioli & Scott, 1989. *Birna griggae* (McDonald), comb. n., is transferred from *Linea* McDonald.

Introduction

McDonald (2003) proposed the name *Linea* McDonald for a new genus of Pentatomidae (Hemiptera) from northern Australia. This name is preoccupied in the Foraminifera (Schroder *et al.* 1989) and a replacement name is provided below.

Birna nom. n.

Linea McDonald, 2003: 17. Not *Linea* Schroder, Medioli & Scott, 1989.

Type species (automatic): *Linea griggae* McDonald.

Etymology. Birna is the word for bug in the Yindjibarndi language spoken by the indigenous people of the Pilbara region in Western Australia. The gender is to be taken as feminine.

Birna griggae (McDonald), comb. n.

Linea griggae McDonald, 2003: 19.

Description. See McDonald (2003).

Acknowledgements

I should like to thank David Rider (North Dakota State University and the Zoological Record) for alerting me to the homonymy of *Linea* McDonald. I should also like to thank David McAlpine (Australian Museum, Sydney) for his help in correctly formatting this paper.

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THE RETURN MIGRATION OF BOGONG MOTHS, *AGROTIS INFUSA* (BOISDUVAL) (LEPIDOPTERA: NOCTUIDAE), FROM THE SNOWY MOUNTAINS, NEW SOUTH WALES

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Abstract

The return (autumnal) migration of *Agrotis infusa* (Boisduval) from the Snowy Mountains commences after most plants have finished flowering, and the return journey to the plains to breed is generally against the general direction of the wind. At the commencement of these flights, bogong moths were recorded flying into the wind, which was a head wind at all altitudes up to 4000 m, and were observed feeding on honeydew.

Introduction

The bogong moth, *Agrotis infusa* (Boisduval), has a mixed biology. In some populations there are spring and autumn generations and no migration. Other populations are univoltine, with adults emerging in spring and migrating up to 1000 km from the western slopes and plains of New South Wales and southern Queensland, to aestivate in rock crevices in the mountains on and adjacent to the Great Dividing Range (Common 1954). The spring migration has been well documented (Common 1954), but post-diapause migrations of insects are generally not as obvious nor as well described as pre-diapause flights, because there are fewer insects involved and the migration flight is thought to be more scattered (Johnson 1969).

During the spring migration, bogong moths have been reported feeding on a number of plants, such as forest and orchard trees, garden flowers and shrubs (McCarthy 1945) and nectar of eucalypt and other flowers (Common 1981). Common (1981) reported bogong moths 'migrating back to their breeding areas, where nectar is again sought before mating' but did not comment on the food used during the actual migration. Moths must make the return migration at a time in autumn when temperatures are low, winds are generally not favourable, most plants have finished flowering, and the moth's body fat is depleted. In these conditions, the food that provides fuel for the return migration is crucial but has not as yet been documented.

Results and discussion

On 10 April 2005, at about 1800 h on an island in Valentines Creek at 1800 m asl, SSE of Mt Jagungal (36°08.5'S, 148°23.2E), I observed fast-flying moths moving unidirectionally northward to where the sky was still light just after sunset; there was no moon. The direction of flight was almost exactly northerly, just off the wind which was from the NNW averaging 8 km/hr and peaking at 14.5 km/hr during observations with a hand-held weather station (Kestrel 3000). The temperature was 14.5°C, in humid conditions leading to a thunderstorm within an hour of the observations.

Looking south, where it was almost dark, and without moving my head, I counted all fast-flying moths passing my vision until 200 had passed. This took 3.5 minutes, which equals 57 moths per minute. The angle of view was small and unquantifiable. Common (1954) used a vertical light beam to count return migration of bogong moths from Mt Gingera and, on 11 April 1952, counted 13-27 per minute at 2-5 m off the ground, which was the approximate height of the flight I observed. Moths were flying fast into a wind that was coming up-valley from the NNW.

There are two distinct ways in which moths migrate. In the first, they may ascend to considerable altitude in rising, warm air and be transported downwind (Drake and Farrow 1988, Gatehouse 1997). In this type of migration the moths cannot feed, have little control over their ultimate destination and may travel great distances in a short time. Alternatively, the moths remain close to the ground (in the boundary layer) and control the direction in which they fly, often having to fly upwind (Johnson 1969). They are able to feed during the migration, may take much longer to travel long distances and may arrive at a definite destination.

Moths migrating close to the ground may be caught in updrafts and taken downwind for great distances, particularly in spring when winds are more violent. Bogong moths trapped like this may reach New Zealand (Common 1981). Captures of moths in northern NSW suggest downwind movement in the geostrophic layer (Gregg *et al.* 1994). In nearly all autumnal records by Common (1954), the wind at ground level was either a cross wind or a head wind, as in the present observations where moths were flying fast into a gentle breeze. There were no favourable winds at higher altitudes. Bureau of Meteorology recordings from Canberra Airport (120 km to the north), throughout the day and into the evening of 10 April 2005, showed consistently NW to N winds at all altitudes up to above 4000 m (15000 feet), moderating from 100 km/hr in the morning to 40 km/hr in the evening (Bureau of Meteorology, pers. comm.).

There has been much research into the assistance that wind gives to migrating insects (Drake and Farrow 1988, Gregg *et al.* 1994), with the implication that bogong moths are just passengers on the wind. However, to be able to locate the same mountain tops for aestivation suggests some control over the direction taken by the moths, as does the ability to migrate back to natal sites against generally unfavourable wind conditions. In these unassisted conditions, autumnal migration would be energetically more expensive, with access to food critical for moths that are returning to breed.

After counting the moths, the shrubs on the island were examined. This revealed thousands of bogong moths, with up to 50 moths on a single shrub. Shrubs containing moths were both epacrids: *Epacris microphylla* s.l. and *E. paludosa*. Other shrubs in the vicinity, *viz. Kunzea muelleri*, *Olearia algida*,

Grevillea australis, Nematolepis (Phebalium) ovatifolium and the heath *Richea continentis,* had no moths.

Several plants of the two *Epacris* species were examined; only *E. microphylla* that had lerps (Homoptera: Psyllidae) had any moths on them, whereas all *E. paludosa* had lerps and all also had bogong moths. The moths were examined closely by headlamp; all had their proboscides extended and appeared to be feeding. Feeding on the sugary exudate (honeydew) of lerp-forming bugs has been recorded for noctuids (Common 1990), but this is the first record for bogong moths (Ted Edwards pers. comm.). *Epacris paludosa* grew mainly along the rocky banks of Valentines Creek but no moths were observed drinking in the creek.

Light traps set for five years on Point Lookout (1560 m) in northern NSW, about 50 km inland from Coffs Harbour, showed spring numbers of bogong moths (going south) peaking in October or November, with the return migration peak in February/March and a decrease in numbers in April (Gregg *et al.* 1993). The migration recorded in the present study was past the peak recorded by Gregg *et al.* (1993), but the timing was not particularly late.

Although return migration to the natal grounds commences in about March (Common 1954), Green (2003) recorded bogong moths in the mountains, sunning themselves on rocks in May, and bogong moth remains in fox scats in June. Presumably, there is a balance of advantages and disadvantages in the timing of the return migration; the later the migration the greater the chance of autumnal rains and plant growth in the natal sites but also the greater the lack of food for the return journey. The use of honeydew may well alleviate this lack of flowering plants on the return migration.

Acknowledgements
I thank Ted Edwards for many discussions on bogong moths and comments on the manuscript. Dave Woods identified some of the plants.

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LIFE HISTORY NOTES ON *LEUCOMONIA BETHIA* (KIRBY) (LEPIDOPTERA: SPHINGIDAE)

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Abstract

Notes are presented on the life history of *Leucomonia bethia* (Kirby). The larval food plant is *Clerodendrum floribundum* R. Br. (Verbenaceae).

Introduction

Leucomonia bethia (Kirby) is the only known species within the genus *Leucomonia* Rothschild & Jordan. It has a wide distribution across northern Australia (D'Abrera 1987) but nothing has been published to date on its biology. During January and February 2005, eggs and early instar larvae of *L. bethia* were found near Granite Creek, 15 km northwest of Atherton in northern Queensland. These were reared through to adults and the following observations recorded.

Life history

Food plant. *Clerodendrum floribundum* R. Br. (Verbenaceae).

Egg (Fig. 1). Spherical; 1.5 mm in diameter; pale green; laid singly on upper or undersurface of food plant leaf.

First instar larva (Fig. 2). Length 5-8 mm. Head, body and legs light green (almost translucent). Caudal horn dark brown, directed backwards and extending away from body, turned upwards slightly with extreme upper tip bifurcate.

Second instar larva (Fig. 3). Length 8-20 mm. Body and legs light green; a mid-lateral band, adorned with fine pale yellow spots, extends along thoracic and abdominal segments. Head and anal claspers darker green, also adorned with fine yellow spots. Caudal horn brown, clothed in brown setae, raised at approximately 30° and turned upwards slightly, with extreme upper tip also bifurcate but not as distinctly as in the first instar.

Third instar larva (Fig. 4). Length 20-32 mm. Head, body and legs green (darker than first and second instars). Head, body and upper prolegs with slightly raised yellow spots; seven pale yellow oblique stripes along abdominal segments 1-8, arising anterior to and below spiracles and terminating on dorsal surface of abdomen; posterior stripe terminating at base of caudal horn. Caudal horn brown, nearly straight, angled at approximately 45°, with brown setae.

Fourth instar larva (Fig. 5). Length 32-55 mm. Head, body and legs green, with slightly raised fine yellow tubercles. Thorax with legs light brown; a series of raised green or brown tubercles on anal prolegs and on dorsal surface of thoracic segments; lateral oblique stripes more prominent,

coloured yellow with upper dark green edging. Caudal horn straight, brown with yellow underside, clothed in fine, raised tubercles. Spiracles brown, with surrounding narrow yellow ring.

Fifth instar larva (Figs 6-8). Length 55-80 mm. Head, body and legs with markings as in fourth instar, but larva more stocky. Green or brown tubercles on anal prolegs prominent; yellow tubercles on body often less prominent and in green colour form (see below) often lacking; lateral oblique stripes coloured white with upper dark green edging. Caudal horn dark brown, curved slightly backwards, with raised brown tubercles. Raised tubercles on thoracic segments either green or brown. Fifth instar larvae occur in both green (Fig. 6) and brown (Fig. 7) colour forms, with intermediate (Fig. 8) forms occurring.

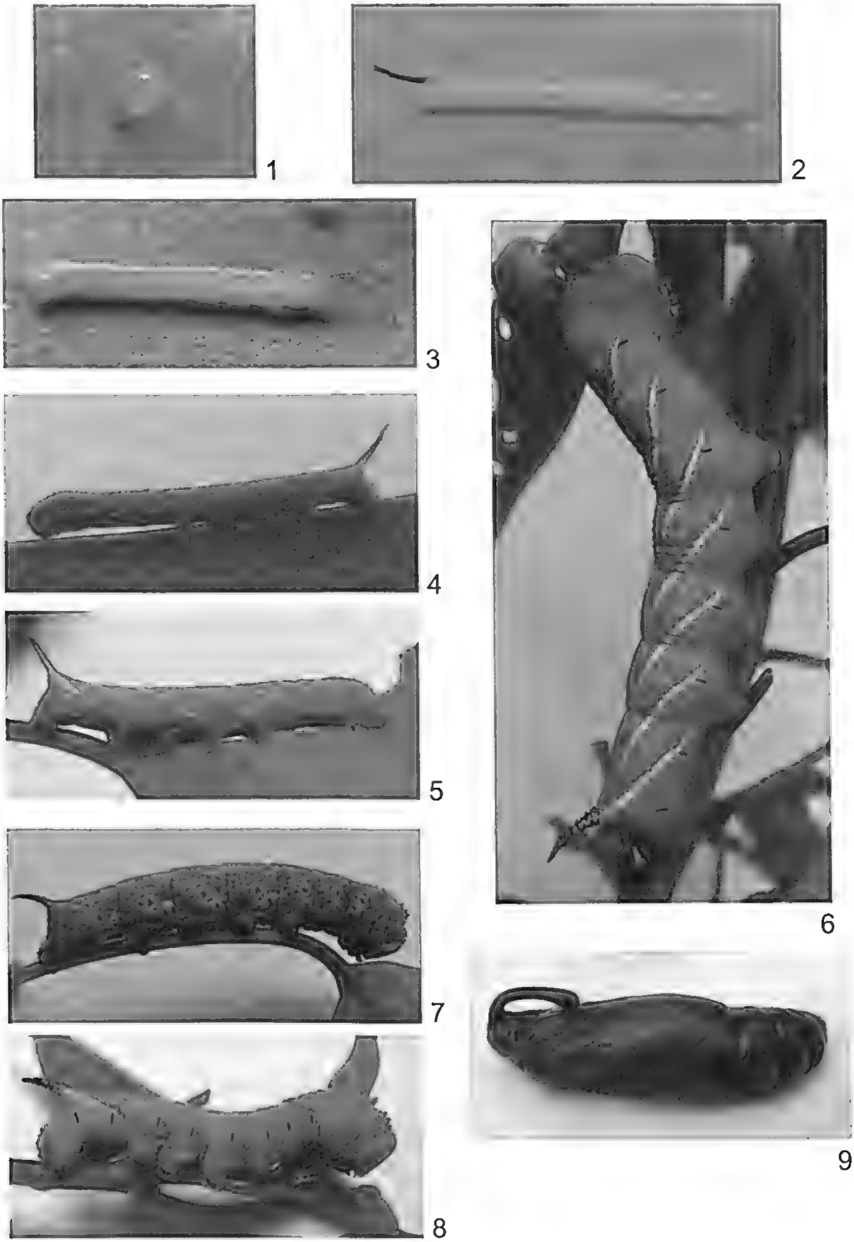
Pupa (Fig. 9). Dark brown; haustellum case well developed and about one quarter length of pupa. Cremaster black, deeply pitted, in dorsal view nearly an equilateral triangle, terminating in a pair of distally directed, sharp spines about one third width of length; these spines are basally wider and angled more obtusely away from body axis compared with those on the pupal cremaster of *Psilogramma argos* Moulds & Lane. In lateral view, cremaster sides nearly straight and parallel sided, tilting upward from body axis. Pupa similar in overall shape and form, but much darker brown in colour, than that of *P. argos* (Moulds and Lane 1999).

Observations

Larvae normally rest on the undersurface of food plant leaves and are remarkably well camouflaged, as the combination of green colouration with diagonal striping gives the impression of filtered sunlight. During particularly hot days, mature larvae (especially brown colour forms) were observed at the base of food plant trees, resting head upwards with caudal horns touching the ground. This situation possibly afforded more shade and slightly cooler conditions, and also may have aided camouflage.

At the time of year observed (January-February), third to fifth instar larvae were heavily parasitised by tachinid flies, with up to 90% mortality rate. Such final instar larvae continued to feed, but developed slowly. Attempts at pupation usually failed, as the limp larval body rapidly decomposed after multiple fly larvae exited.

Before pupating, final instar larvae first turn a purplish colour, then leave the food plant and may wander considerable distances before finding a suitable pupation site.



Figs 1-9. *Leucomonia bethia*. (1) egg; (2) first instar larva; (3) second instar larva; (4) third instar larva; (5) fourth instar larva; (6-8) fifth instar larvae: (6) green colour form (note the parasitic strike marks on abdominal segment 1); (7) brown colour form; (8) intermediate colour form; (9) pupa, lateral view.

In captivity, purplish coloured larvae were placed in suitable containers containing 150 mm of bedding soil. Some burrowed immediately and others wandered for up to several hours before burrowing to pupate. In this situation, they constructed cells made of soil lined with silk and pupated within these cells. Adults emerged from pupae after two to three weeks.

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A SURVEY OF INSECT PESTS BREEDING IN MANGO FRUIT IN DILI, EAST TIMOR

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Abstract

A survey of 1345 mango fruit from 231 trees in Dili detected a 9.5% prevalence of *Deanolis sublimbalis* Snellen (Lepidoptera: Pyralidae) and a 14.7% prevalence of *Bactrocera* spp. fruit flies (Diptera: Tephritidae). No other mango fruit borers were detected and it is very unlikely that they occur in Dili. The absence of *Sternochetus frigidis* F. and *S. mangiferae* (F.) (Coleoptera: Curculionidae) suggests a low probability of their presence in East Timor.

Introduction

In Southeast Asia, a number of insects have been reported breeding in mango fruit, particularly red-banded mango caterpillar, *Deanolis sublimbalis* Snellen (Lepidoptera: Pyralidae), mango pulp weevil, *Sternochetus frigidis* Fabricius and mango seed weevil, *Sternochetus mangiferae* (Fabricius) (Coleoptera: Curculionidae), several *Bactrocera* Macquart species (Diptera: Tephritidae) and an undescribed species of *Nephopteryx* Hübner (Lepidoptera: Pyralidae) (Kalshoven 1981, Waterhouse 1993, Allwood *et al.* 1999, Anon 1999, Smith 1999). These pests not only affect fruit production through reduction in yields but can also impinge on exports, since many countries impose strict quarantine requirements on the import of fruit potentially infested with one or more of these pests.

Deanolis sublimbalis, S. frigidis and *Bactrocera* spp. have been reported from Indonesia but confirmed records from many of the individual islands in the Indonesian archipelago, including Timor, are lacking (Kalshoven 1981, Anon 1993, Drew and Hancock 1994). Consequently, the status of these pests on mango fruit in East Timor, a newly independent country which lies in this archipelago, is unclear.

Many species that breed in mango fruit are difficult to find as the only means of detection is to sample fruit destructively. Additionally, mangoes are very seasonal and provide only a brief window of opportunity to sample fruit. In many areas, fallen fruit is quickly eaten by domestic animals, making large scale sampling difficult. This paper reports the results of a recent survey for mango fruit pests in Dili, East Timor.

Materials and methods

Mango fruit were collected from fruiting trees in backyards in Dili in December 2003 and January 2004. In most cases, five fruit were picked from

each tree, although fallen fruit were also sampled opportunistically. In areas where fruiting trees were scarce, ten fruit were sampled from each tree. Samples from each tree were treated as a unit, so infestation levels were calculated for individual trees rather than for individual fruits. Tree owners were shown photographs and specimens of *D. sublimbalis* and *Sternochetus* sp. larvae and asked if these insects ever occurred in their fruit.

Fruit maturity, as gauged by flesh colour, was recorded for each mango sampled. Mangoes, including seeds, were dissected using a knife or secateurs and examined for the presence of borers or borer damage. The position within the fruit of borers or damage was recorded and all borers were collected, immersed in freshly boiled water for 5 minutes, then preserved in 70% ethanol for subsequent morphological examination.

The confidence level that pest specimens not detected in the samples were absent from the sampled population, was calculated using the formula of Cannon and Roe (1982):

$$\alpha \cong 1-\left(1-\frac{d}{N-(n-1)/2}\right)^{n}$$

where N is the estimated population size, d is the number of positives in the population and n is the number sampled. Confidence levels were calculated using an upper and a lower estimate for N, the number of fruit in the Dili growing region using a lower estimate of 90,000 (300 trees each producing an average of 300 fruit) and an upper estimate of 200,000 (400 trees each producing an average of 500 fruit), and d was given the value of 1. The result is the confidence level expressed as the probability of finding less than 1 infected fruit in the sample.

Results

Ten fruits from each of 38 trees and five fruits from each of 193 trees were sampled, giving a total of 1345 fruit from 231 trees. It was estimated that the majority of fruiting trees in Dili were sampled. A total of 1221 fruit (90.8%) were picked from trees, while 124 fruit (9.2%) were collected from the ground beneath fruiting trees. Three maturity stages were represented, with 114 mature (orange flesh), 102 partially mature (yellow flesh) and 15 immature (white/pale yellow flesh) samples respectively.

Deanolis sublimbalis and tephritid fruit flies were the only primary pests observed. Forty-eight specimens of *D. sublimbalis* were collected from 22 trees, indicating a prevalence of infestation of trees of 9.5%. *D. sublimbalis* were only collected from picked fruit. The infestation rates relative to fruit maturity are given in Table 1. All specimens of *D. sublimbalis* were found in the seed, although damage to flesh was usually also evident.

Table 1. Infestation rate of *Deanolis sublimbalis* relative to maturity of mango fruit examined in Dili, East Timor.

Fruit maturity	% of larvae collected	Infestation rate (%)
Mature	45	7.9
Partially mature	10	2.9
Immature	44	66.7

Fruit fly larvae (*Bactrocera* spp.) were present in 34 (14.7%) samples. All but four of the samples infested by *D. sublimbalis* were also infested by fruit flies and all but one of the samples infested by fruit flies were also infested by opportunistic beetle species (adult scarabaeids and nitidulids). Tree owners agreed that these were the only insects ever seen in the fruit.

The probability (level of confidence) that mango fruit-boring insects not detected in the samples are absent from the Dili mango growing region was calculated to be between 98.5% and 99.3%, depending on which estimate of the number of fruit produced in Dili was used.

Discussion

Dili serves as a major market for fruit grown in surrounding areas of East Timor. Consequently, pests able to be transported in infested fruit would be expected to be continuously brought into Dili for sale and subsequently become established there. Their absence in Dili suggests that other areas of East Timor may also be free of such pests. This is particularly true for *Sternochetus frigidis* and *S. mangiferae*, which can infest up to 80% of mango fruit and do not affect the external appearance (Cunningham 1991, Kalshoven 1981). Where these pests are present, infested fruit are likely to be harvested and sold in the marketplace.

The presence of *Deanolis sublimbalis* in East Timor is not surprising. This species has been reported from across Indonesia as far east as Papua New Guinea (Kumar 2001). A prevalence of 9.5% is comparable with that observed in the Philippines by Golez (1991) and probably does not impinge significantly on mango production. Mangoes of varying states of maturity harboured caterpillars, which agrees with the observations of Golez (1991). The relatively higher infestation rate of immature fruit may be due to a tendency for infested fruit to fall prematurely (Kalshoven 1981), thereby reducing the proportion that remain on the tree until maturity.

Several species of fruit fly, *e.g. Bactrocera papayae* Drew & Hancock, *B. carambolae* Drew & Hancock and *B. albistrigata* (de Meijere), which are important pests of mangoes, are known to be present in Timor (Drew and Hancock 1994, Allwood *et al.* 1999, Bellis and Brito unpublished data). No attempt was made in this study to identify larvae collected in this study so the actual species involved are not known. The prevalence of fruit flies in

mangoes may underestimate true rates as many immature fruit were sampled and these are often less frequently attacked by fruit flies than are mature fruit.

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THE BUTTERFLIES (LEPIDOPTERA) OF MIDDLE, MONDRAIN, SANDY HOOK, WOODY AND GOOSE ISLANDS IN THE RECHERCHE ARCHIPELAGO, WESTERN AUSTRALIA

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Abstract

Twelve butterfly species are recorded from Middle, Mondrain, Sandy Hook, Woody and Goose Islands in the Recherche Archipelago, Western Australia: *Hesperilla chrysotricha chrysotricha* (Meyrick & Lower), *Delias aganippe* (Donovan), *Pieris rapae rapae* (Linnaeus), *Geitoneura klugii* (Guérin-Méneville), *Heteronympha merope duboulayi* (Butler), *Junonia villida calybe* (Godart), *Vanessa kershawi* (McCoy), *Vanessa itea* (Fabricius), *Nacaduba biocellata biocellata* (C. & R. Felder), *Theclinesthes serpentata serpentata* (Herrich-Schäffer), *Neolucia agricola occidens* Waterhouse & Lyell and *Zizina labradus labradus* (Godart). Their status on the islands is discussed and the butterfly fauna compared with that of other Western Australian islands.

Introduction

The islands of the Recherche Archipelago are located off the southern coastline of Western Australia, from Esperance eastwards. About 200 islands make up the archipelago; some lie close to the coast while others are a considerable distance off shore. The furthest, Salisbury Island, is 50 km southeast of the mainland at Cape Arid. In November of 1998, 1999 and 2003, we surveyed five of the larger islands for butterflies: Middle (34°06'S, 123°11'E); Mondrain (34°08'S, 122°15'E); Sandy Hook (34°02'S, 122°00'E); Woody (33°58'S, 122°01'E); and Goose (34°05'S, 123°11'E). Prior to these visits, no butterflies had been recorded from the archipelago.

The islands are mostly granitic remnants of the Precambrian Shield (Brown *et al.* 1984). Middle Island (1060 ha) is the largest and physiographically most diverse of the islands. It lies about 8.5 km SSE of Cape Arid and 120 km ESE of Esperance. Its topography is dominated by Flinders Peak (174 m), a large granite dome at the western end of the island. The coastline is very irregular, with numerous promontories and coves with white sandy beaches. In some places limestone overlies the granite substrate. Lake Hillier, a pink, hypersaline lake, is located in the northeast of the island. The vegetation on Middle Island is diverse and 20 vegetation associations have been mapped (Hopkins 1981); 235 plant species are now recorded (Keighery 1995). Half the island was burnt in a fire in 1972 and almost all the rest in 1977. The areas burnt now support dense regrowth vegetation.

Mondrain Island (787 ha) is the second largest island in the Recherche. It lies 42 km SE of Esperance and some 11 km from the mainland. It is irregular in shape, 6 km long and 2.8 km wide at its widest point. Permanent or semi-permanent water is found in seepage areas on the western side of the island and in rock pools on Baudin Peak (222 m), the island's highest point. The

island is characterised by a series of granite domes with large expanses of bare rock. The vegetation is varied and some 283 native species are recorded (Pearson *et al.* 2004). In shallow soils between the granite domes is dense scrub, predominantly of *Melaleuca globifera, Acacia conniana* and *Allocasuarina huegeliana*. In swales, where the soil is deeper, low forest of *Eucalyptus lehmanni* occurs. Open sandy areas support *Carpobrotus virescens* and meadows of yellow-flowered *Senecio lautus*, especially where nesting shearwaters have enriched the soil. In other areas dense *Rhagodia baccata* and *Atriplex cinerea* occur.

Sandy Hook Island (238 ha) is located 9 km WSW of Cape Le Grand and 22 km WNW of Mondrain Island. Like other islands in the archipelago it is characterised by large granite domes and boulders. Much of the interior is a high plateau overlain with shallow sand and gravel, which supports a dense eucalypt and shrub association (Willis 1953). On the southeastern side of the island is a small sandy cove, above which is a sheltered wooded gully. The gully vegetation is dominated by *Eucalyptus conglobata*, *Acacia* and *Hakea* species. Introduced grasses, thick in places, are well established.

Woody Island (196 ha) is located in Esperance Bay, 7 km from the mainland and 15 km SE of Esperance. It is about 2 km (E-W) by 1.5 km (N-S) and rises at its centre to 130 m. It is composed of granite, which is frequently exposed between areas of shallow overlying soil. The island is well vegetated. The shallow soils support variable heath and mallee formations. Eucalypt forest is found in areas of deeper soil. Abbott and Black (1978) recognised six vegetation classes; the two main ones are low open-heath on the western half of the island and *Eucalyptus*-dominated closed forest on the sheltered slopes south and east of the summit. The island has been grazed in the past and parts of the northeastern portion are still cleared.

Goose Island (56 ha) is the smallest of the islands to be surveyed for butterflies. It lies less than a kilometre to the north of Middle I. and 7.5 km from the mainland. Its highest point is a gently sloping, exposed granite dome.. Limestone cliffs are found on the eastern side of the island. The vegetation is generally very low, in response to the shallow soils and probably also to grazing by rabbits, which have been introduced to the island. The presence of rabbits probably also explains, to a large degree, the extent to which this vegetation differs in composition from that of nearby Middle I. Dominant species such as *Rhagodia baccata*, *Senecio lautus* and *Carpobrotus virescens* are uncommon on Middle I. *R. baccata* is found in sandy areas honeycombed with petrel burrows. Shrubs of *Pimelea ferruginea* occur in shallow soils near sheets of exposed granite.

Methods

Butterfly surveys of the Recherche islands were carried out in November of 1998, 1999 and 2003, at the time of year when peak butterfly activity is to be expected on the adjacent mainland. It was not possible to visit all five islands

in a single year. Most time was devoted to the largest islands, Middle and Mondrain, with their more diverse habitats. Four days were spent on Middle Island, in 2003, and a total of five days on Mondrain, in 1998 and 1999. Woody Island was visited for one day and Sandy Hook Island for just a few hours in November 1998. A further day spent on Sandy Hook Island in 1999 by one of us (AW) was generally unproductive, due to cool, cloudy conditions. Goose Island was surveyed for a few hours in November 2003 during the Middle Island expedition. Suitable sunny conditions for butterflies were experienced on each survey trip. One of us (RP) spent a few hours on Woody Island in December 1993, and his opportunistic observations are included in this paper.

Prior to visiting the islands, we identified the major habitat types, with the aid of aerial photographs and published data on the topography and vegetation. Published plant lists were scrutinised for known butterfly food plants. During our surveys, all accessible types of habitat were carefully explored and food plants, when encountered, were examined for signs of larvae. Accessible hilltops were monitored for hilltopping butterflies. Botanical nomenclature follows Green (1985).

Results

The results of our survey are summarised in Table 1. Voucher specimens have been lodged in the Insect Collection of the Department of Conservation and Land Management or (plants) in the Western Australian Herbarium.

HESPERIIDAE

Hesperilla chrysotricha chrysotricha (Meyrick & Lower)

Recorded from Middle I. Locally abundant around the food plant, *Gahnia trifida* (Cyperaceae), growing in a narrow belt along the eastern shoreline of Lake Hillier. In the early mornings, males were observed flying amongst the *Gahnia* foliage, presumably in search of emerging females. Several pupae were found in typical sealed cylindrical shelters on the food plant.

PIERIDAE

Delias aganippe (Donovan)

Recorded from Woody I. This species was not observed during the surveys in 1998, 1999 and 2003. However, several specimens were seen by one of us (RP) on an earlier trip to Woody I. in December 1993.

Pieris rapae rapae (Linnaeus)

Recorded from Mondrain, Sandy Hook and Woody Is. On Woody I., a few individuals were seen on the eastern side of the island, particularly in cleared areas near the landing point. On Sandy Hook I. the species was not seen in 1998. A single individual was observed in November 1999, even though the weather on that visit was cool and overcast. On Mondrain I. *P. r. rapae* was usually uncommon. However, in 1998, after a period of off-shore north-easterly winds, the species suddenly became abundant.

Table 1. Butterflies recorded from Middle, Mondrain, Sandy Hook, Woody and Goose Islands of the Recherche Archipelago.

Family and species	Middle	Mond-rain	Sandy Hook	Woody	Goose
HESPERIIDAE					
Hesperilla chrysotricha chrysotricha	•				
PIERIDAE					
Delias aganippe				•	
Pieris rapae rapae		•	•	•	
NYMPHALIDAE					
Geitoneura klugii			•		
Heteronympha merope duboulayi				•	
Vanessa kershawi	•	•		•	•
Vanessa itea	•	•		•	
Junonia villida calybe	•	•		•	
LYCAENIDAE					
Nacaduba biocellata biocellata				•	
Neolucia agricola occidens	•	•	•	•	
Theclinesthes serpentata serpentata		•	•	•	•
Zizina labradus labradus	•	•		•	
Total number of species: 12	**6**	**7**	**4**	**10**	**2**

NYMPHALIDAE

Geitoneura klugii (Guérin-Méneville)

Recorded from Sandy Hook I. This species was encountered only on the eastern side of the island, in a sheltered valley above the landing beach. Butterflies were collected around patches of *Austrostipa flavescens* Labill. (Poaceae), a known larval food plant.

Heteronympha merope duboulayi (Butler)

Recorded from Woody I. The common brown was not recorded during the surveys in 1998, 1999 or 2003, which took place in the first half of November and may have preceded the butterfly's appearance. RP, in his brief visit to Woody I. on 28 December 1993, recorded one female. Robyn Benken (pers. comm.) found the species to be abundant during her visit on 12-13 December 2004; all specimens she was able to observe closely were male.

Vanessa kershawi (McCoy)

Recorded from Middle, Mondrain, Woody and Goose Is. On Middle I., numbers of fresh specimens were observed along the sheltered north-facing and eastern coastline. Inland they were also common around Lake Hillier. The butterflies were often seen feeding at flowering shrubs of *Pimelea ferruginea* and *Senecio lautus*. On Mondrain I. the species was encountered in 1998 and 1999. Butterflies were commonest in open meadows of flowering *Senecio lautus* and *Carpobrotus virescens*. This habitat is often

found in nutrient enriched soils honeycombed with the burrows of the fleshy-footed shearwater (*Puffinus carneipes* Gould). On Woody I., *V. kershawi* was common in cleared areas near the landing point on the eastern side of the island. Adults were seen feeding on the flowers of *Senecio lautus* and the introduced *Arctotheca calendula. A. calendula* (Asteraceae) is a known food plant and *V. kershawi* was seen ovipositing on this plant. On Goose I. two specimens were observed, feeding on the flowers of *Pimelea ferruginea.*

Vanessa itea (Fabricius)

Recorded from Middle, Mondrain and Woody Is. The yellow admiral was commonest on Mondrain and Woody Is, where its food plant *Parietaria debilis* (Urticaceae) was abundant. On Mondrain I., adults were seen in coastal areas and upland meadows of flowering *Senecio lautus* and *Carpobrotus virescens*. Large numbers of larvae were found on *P. debilis*, which was growing profusely under dense stands of *Melaleuca lanceolata.* Some were collected and subsequently reared in captivity. On Woody I., about six adults were seen in the late morning to early afternoon. Four or more were seen hilltopping after 1630 h at the island's highest point. *P. debilis* was abundant and typical larval shelters were found in three or more places. On both Mondrain and Woody Is, many of the *V. itea* were freshly emerged. On Middle I. only a few plants of *P. debilis* were found, under a small stand of *M. lanceolata* north of Lake Hillier that had escaped the two major fires. On this island *V. itea* was uncommon; only about six individuals were seen over four days. Some of these fed briefly at the flowers of *Pimelea ferruginea*. One of the plants of *P. debilis* had a typical larval shelter.

Junonia villida calybe (Godart)

Recorded from Middle, Mondrain and Woody Is. On Middle I., the species was encountered only on the rocky promontory between Coverdale Cove and Cormorant Cove. At this site three worn males had established territories along the rocky shoreline. On Mondrain I. the species was also scarce. A fresh specimen was captured on an exposed granite sheet in November 1998, and none was seen in 1999. Only on Woody I. was the butterfly common. Several specimens were observed and collected at the eastern end of the island near the landing point. The species was observed with *V. kershawi* on flowering *Senecio lautus* and flying along pathways and in open areas.

LYCAENIDAE

Nacaduba biocelata biocellata (C. & R. Felder)

Recorded from Woody I. This common lycaenid was encountered only on Woody I. A few individuals were seen near the summit of the island, around freshly opened flowers of *Acacia rostellifera.*

Neolucia agricola occidens Waterhouse & Lyell

Recorded from Middle, Mondrain, Sandy Hook and Woody Is. Fringed heath-blues were found on all but Goose I. On Middle I. they were plentiful.

Butterflies were almost always seen close to flowering shrubs of *Pultenaea obcordata* or *Eutaxia obovata*, which were common on the southeastern side of Lake Hillier and along the northern and eastern coastline. By contrast, the species was uncommon on the other islands. One freshly emerged specimen was captured on a low flowering *Acacia rostellifera* near the summit of Woody I. On Sandy Hook I., a specimen was collected flying round a *Hakea* shrub. On Mondrain I., one butterfly was collected in 1998 and another closely observed on a shrub at the northern end of the island in 1999.

Theclinesthes serpentata serpentata (Herrich-Schäffer)
Recorded from Mondrain, Sandy Hook, Woody and Goose Is. Saltbush blues were seen mostly near one of their food plants, *Rhagodia baccata* (Chenopodiaceae); no other species of food plant was encountered. We recorded this butterfly on all the islands except Middle I., where we found very few *Rhagodia* specimens. On Middle I. it was evident that this plant's occurrence had been much reduced by grazing Tammar wallabies (*Macropus eugenii* (Desmarest)). On Mondrain I., the butterflies were abundant in 1998, around *Rhagodia baccata* above the landing beach on the northeastern side of the island. On the return visit, in 1999, the butterflies were absent from this site. On Sandy Hook I. one butterfly was seen (but not collected) in 1998. On Woody I. the species was moderately common in low-lying, partly cleared areas on the sheltered northeastern side. Here, too, the butterflies were found near *R. baccata*. On Goose I., where succulent mats of *R. baccata* grow extensively in nutrient enriched sandy areas honeycombed with shearwater burrows, freshly emerged butterflies were abundant.

Zizina labradus labradus (Godart)
Recorded from Middle, Mondrain and Woody Is. On Middle I. the species was uncommon. Two individuals were found on the northern coastline between Coverdale Cove and North East Point, one feeding on a flowering *Senecio lautus*. On Mondrain I. it was recorded in 1998 and 1999. On our first visit, *Z. l. labradus* was not seen for the first three days and appeared on the island only after a prolonged period of strong off-shore winds. The butterflies were first observed about 0930 h on 12 November 1998; by late morning they had become abundant and were frequently seen on the slopes of the hill at the northern end of the island, in meadows and around vegetation between granite sheets. In 1999 only one butterfly was recorded. On Woody I., *Z. l. labradus* was locally common near the landing point.

Discussion

In considering the behaviour and ecology of butterfly species on islands, of particular interest is their status. They can be present either permanently or temporarily, referred to here as 'permanent' or 'temporary' species.

For a permanent species, the population is likely to be composed entirely or largely of individuals that are resident on the island. There may be a viable,

isolated population, comprising resident individuals with no influx from elsewhere, or such an influx may occur, boosting a resident population. In the latter case, the resident population may to some degree rely on the influx for its viability. If the butterfly population is to remain permanent, however, it cannot rely on that influx too heavily, since there are bound to be years or times when the usual influx does not occur (for example, as a result of a mainland population being destroyed by fire).

Most of the permanent species might be expected to have a single generation a year, since such species need a food plant only at the time the larvae are feeding. Those species that have continuous generations would normally need to have food plants available in a suitable state of growth throughout the year, to allow each new generation to breed; this is unlikely on islands, with their limited number of plant species. An influx of adults from elsewhere cannot be relied on to maintain the presence of a species with continuous generations at times of the year when it is unable to breed.

The temporary species will all be ones able to travel to the island from elsewhere. Some may go there deliberately, either to breed when the season or conditions are right or to rest during a migration. Others may be there by accident, having the intention of remaining on the mainland but being displaced out to sea by off-shore winds.

Four of the species we recorded - *Hesperilla chrysotricha chrysotricha*, *Geitoneura klugii*, *Heteronympha merope duboulayi* and *Neolucia agricola occidens* - are likely to be permanent species on the islands where found.

In Western Australia, *Hesperilla chrysotricha* has one or possibly two generations a year (Braby 2000). Breeding was confirmed on Middle Island. For most of the year the larvae or pupae remain in shelters on the *Gahnia trifida* food plant. This island population is likely to be an isolated one, viable enough to have persisted since the island was formed. The fire in 1972 burnt the eastern part of the island, including the *Gahnia* vegetation fringing the eastern side of Lake Hillier. However, isolated clumps of the food plant may have survived on the northern side of the lake. Moreover, *G. trifida* occurs also on the lower eastern slopes of Flinders Peak (A.J.M. Hopkins, pers. comm.). Either part of the lakeside population may have survived, or recolonization may have occurred from a population at Flinders Peak.

Neolucia agricola has one generation a year (Braby 2000) and is not known to be very mobile. Its populations on the islands are likely to be isolated ones that have persisted. On Middle Island the butterflies were very common and were habitually seen around flowering shrubs of *Pultenaea obcordata* and *Eutaxia obovata*. (Fabaceae). These are likely food plants, as other *Pultenaea* and *Eutaxia* species are known larval food plants. A potential food plant, *Bossiaea dentata*, occurs on the other islands where *N. agricola* was recorded.

Geitoneura klugii has only one generation a year (Braby 2000). It is not known to be a very mobile species; our experience in Perth is that it wanders barely at all from the bushlands where it breeds. The population on Sandy Hook I., 8 km from the mainland, is likely to be an isolated one, where the species almost certainly breeds on the native grass *Austrostipa flavescens*.

Given that *Heteronympha merope* has only one generation a year (Braby 2000) and that the grasses on Woody Island include two of its known food plants, *Cynodon dactylon* and *Poa poiformis*, this butterfly may be a permanent breeding species on this island. This likelihood is further emphasized by the apparent abundance of the species on the island. *H. m. duboulayi* has been found to be quite mobile, even though it is not known to migrate (Braby 2000). A specimen recorded on Garden Island may have travelled 2 km or more from the Perth mainland (Williams 1997) and the Woody Island population may possibly be boosted by occasional arrivals from the mainland. Whether or not *H. m. duboulayi* occurs on other islands in the Recherche would need to be determined by surveys in summer.

Most of the eight remaining species are likely to be temporary. For *Vanessa itea*, *V. kershawi* and *Junonia villida*, this is partly because they have continuous generations and partly because they are highly mobile migrants (Braby 2000). That we have recorded them from most of the islands we have visited, including those of the Houtman Abrolhos, 60-80 km off the coast (Williams and Powell 1998), suggests they are easily capable of travelling the much shorter distances between the mainland and the Recherche islands surveyed. Being swift, powerful fliers, they probably rely less on favourable winds for such journeys than do other, less powerful species.

On the Recherche islands, *V. itea* breeds on *Parietaria debilis* and probably also on *Urtica urens*, which is available on Woody Island (Western Australian Herbarium Collection). Both these plants are annuals, which germinate in May or June and die off in November to December. *V. itea* would be unable to persist on the islands over the four to five months when its food plants are unavailable.

V. kershawi likely breeds from time to time on the islands, where likely food plants include *Arctotheca calendula*, *Gnaphalium* sp. and *Rhodanthe* sp. Likewise, *J. villida* may breed on known food plants such as *Centaurium spicatum* and *Scaevola aemula*. It is unlikely, however, that either species would breed on the Recherche islands over the whole year.

Both *Delias aganippe* and *Pieris rapae* are somewhat mobile (Braby 2000). *D. aganippe* is clearly a temporary species on at least Woody Island, since none of its food plants is present. Although we did not find it on any of the other islands, it is likely to visit other islands in the archipelago from time to time, and could breed on Middle Island where a known food plant, *Amyema melaleucae,* occurs. The sudden increase in numbers of *P. rapae* observed on

Mondrain Island after a period of off-shore winds suggests that this species will travel from the mainland to the islands, at least when the winds are favourable. *Cakile maritima* (Brassicaceae), a possible food plant, grows on many of the islands. On the mainland the species is certainly mobile. It was introduced to Melbourne in 1939, and within three years had reached the west coast (Thomas and Lewington 1991). In Europe, large migratory flights occur from time to time.

Although the number of generations a year of *Zizina labradus labradus* has not been recorded, the presence of the adults throughout the year in temperate Australia (Braby 2000) suggests that it breeds continuously. It is therefore probably a temporary species on the Recherche islands. The sudden abundance of this species on Mondrain Island following its apparent absence, and after a period of off-shore winds, strongly suggests that it travels to the islands from the mainland, at least when the winds are favourable.

From the present information, the status on the islands of the remaining two species, *Nacaduba biocellata* and *Theclinesthes serpentata*, is difficult to determine. It is unknown whether *N. biocellata* has a single generation or a succession of generations (Braby 2000), or whether it is sufficiently mobile to travel between the mainland and the islands. The number of annual generations of *T. serpentata* has not been established (Braby 2000). Its absence from the portion of Mondrain Island surveyed in 1999, following an abundance in 1998, indicates that its occurrence on the island may be only temporary. If the Mondrain population is temporary, the same can be expected for the populations on Woody and Goose Islands.

The butterfly fauna on the adjacent mainland has a direct bearing on what butterflies may be expected to occur on off-shore islands. Some species appear to have remained on the islands since their separation from the mainland, supported there by surviving available food plants. Others are now known to be regular visitors to the islands.

V. kershawi, *V. itea*, *J. villida* and *Z. labradus,* have been recorded on all the island groups surveyed: Bernier and Dorre Is, the Houtman Abrolhos, Rottnest, Garden and the Recherche Archipelago (Williams and Hall 1993, Williams 1997, Williams *et al.* 1998, Williams and Powell 1998, Williams *et al.* 2000). All are temporary species, which either visit the islands under their own power or are carried there by off-shore winds.

The silver-spotted ochre, *Trapezites argenteoornatus* (Hewitson), is well established on all but the Recherche islands. Its success can be attributed to the abundance of its food plant *Acanthocarpus preissii* on the west coast islands. Two lycaenids, *T. serpentata* and *N. agricola,* are successful island species. *T. serpentata* occurs on all but Garden Island, where its saltbush food plant is lacking. *N. agricola* appears to breed and maintain stable populations on the Abrolhos and Recherche islands.

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A KEY TO SOME AUSTRALIAN GENERA OF LARGE NOCTURNAL ICHNEUMONIDAE (HYMENOPTERA), INCLUDING FLIGHT PERIODICITIES AND INFLUENCE OF MOON PHASE ON LIGHT TRAP CATCHES

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Abstract

A simple key to some of the genera of large, nocturnal ichneumonid wasps found in southeastern Australia is provided, along with information about their flight periodicities and the influence of moon phase on light trap catches. Approximately 74% of wasps caught were active between 2130 and 0245 h and more were caught on new moon nights than on full moon nights.

Introduction

Large (*i.e.* forewing ≥ 15 mm long), nocturnal ichneumonid wasps are commonly caught when UV light trapping in southeastern Australia and undoubtedly form an important guild of natural enemies of other insects. Similarities in morphology and colouration between different genera may deter non-taxonomists from identifying them, thus limiting the recording of their diversity and abundance.

Nocturnal wasps generally have swollen ocelli, very long antennae and are entirely or almost entirely orange-brown in colour (Fig. 1). This appearance is called the 'ophionoid facies' and occurs mainly in the Ichneumonoidea (Braconidae and Ichneumonidae) and some tropical Chalcidoidea and Vespoidea (Huddleston and Gauld 1988). Many nocturnal parasitic wasps attack the nocturnally active larvae of Lepidoptera (*e.g.* Noctuidae) and Symphyta, some of which are of significant economic importance (Huddleston and Gauld 1988; hosts listed in Table 1). Although similarities in circadian rhythms and their parasitoid lifecycle might logically place them in a single functional group (*i.e.* 'natural enemies'), such a grouping would provide only limited insight into the specific impacts of the different taxa on other biota in a given ecosystem.

Large nocturnal wasps are distinctive and easily extracted from a typical light trap catch. In our studies, Ichneumonidae accounted for all but one of many hundreds of specimens examined from light traps in southeastern Australia,

Table 1. Host records for large nocturnal ichneumonids of Australia (compiled from Gauld 1984). Host families lepidopteran except Pergidae (Hymenoptera).

Ichneumonid taxon	Host family	Host species
Cidaphus	No records	Non-Australian species are secondary parasitoids of moths and sawflies via Ichneumonidae
Hypopheltes	Pergidae	*Perga* sp., *Pseudoperga belinda* Kirby
Megaceria	Geometridae	*Mnesampela privata* (Guenée), *Paralaea* Guest (as *Stathmorrhopa* sp.)
	Notodontidae	Unidentified pupa
Netelia	Noctuidae	*Agrotis infusa* (Boisduval), *Agrotis munda* Walker, *Helicoverpa armigera* (Hübner), *Helicoverpa* sp., *Mythimna convecta* (Walker), *Mythimna separata* (Walker), *Persectania ewingii* (Westwood), *Spodoptera exempta* (Walker), *Spodoptera litura* (Fabricius)
	Pieridae	*Pieris rapae* (Linnaeus)
Ophioninae	Anthelidae	*Anthela varia* (Walker), *Anthela* sp.
	Geometridae	*Chlenias* sp.
	Lymantriidae	*Acyphas* sp.
	Noctuidae	*Mythimna separata* (Walker), *Mythimna* sp., *Persectania* sp.

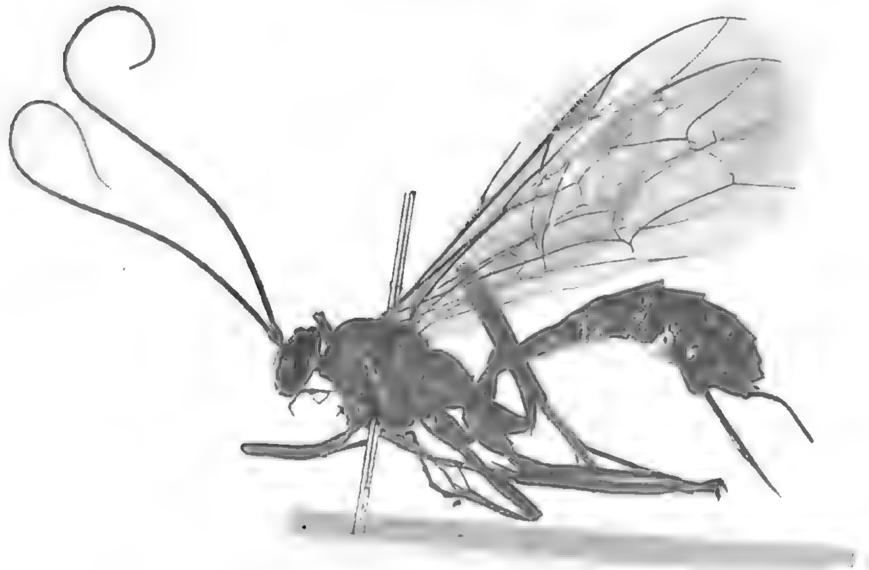


Fig. 1. *Netelia* sp., female. Habitus illustrating an ichneumonid with ophionoid facies (length 18 mm from face to tip of abdomen, excluding ovipositor).

the exception belonging to the family Aulacidae. We collated information about this group while conducting routine light-trapping as part of another study. Accordingly, we compiled a key to the large, nocturnal ichneumonid genera (excluding the Ophioninae – see below). The key is aimed at non-taxonomists and is much less formidable than the keys to Australia's Ichneumonidae provided by Gauld (1984).

We used Gauld (1984) as a guide to the Australian genera of nocturnal Ichneumonidae, supplemented by material in the Australian National Insect Collection, CSIRO Entomology, Canberra, and our own material. The key was constructed by compiling information from Gauld (1984) and with reference to Gauld and Huddleston (1976) and Huddleston and Gauld (1988).

Key to some Australian genera of large nocturnal Ichneumonidae

This key is designed for non-taxonomists and uses only easy-to-see characters of the forewing. However, the eight Australian genera of Ophioninae cannot be separated so easily and have not been included; keys to these genera can be found in Gauld (1977, 1984). Our key is applicable to any ichneumonid with ophionoid facies and a forewing at least 12 mm in length. A key covering smaller ichneumonids would need to include *Anacis* Porter, *Mesochorus* Gravenhorst and perhaps other genera. Light traps also occasionally catch wasps that do not exhibit ophionoid facies. These wasps are probably not nocturnal but might be crepuscular or have been disturbed by the setting up or operation of the trap (Gauld and Huddleston 1976).

1 Forewing with two intercubital veins that enclose a small cell, the areolet (Fig. 2); in *Netelia* lower part of distal intercubital vein often missing 2

– Forewing with a single intercubital vein and no areolet (Fig. 3) .... Ophioninae (not keyed further)

2 First subdiscal cell of forewing much higher at distal end than at proximal end (Fig. 4) .... *Megaceria* Szépligeti

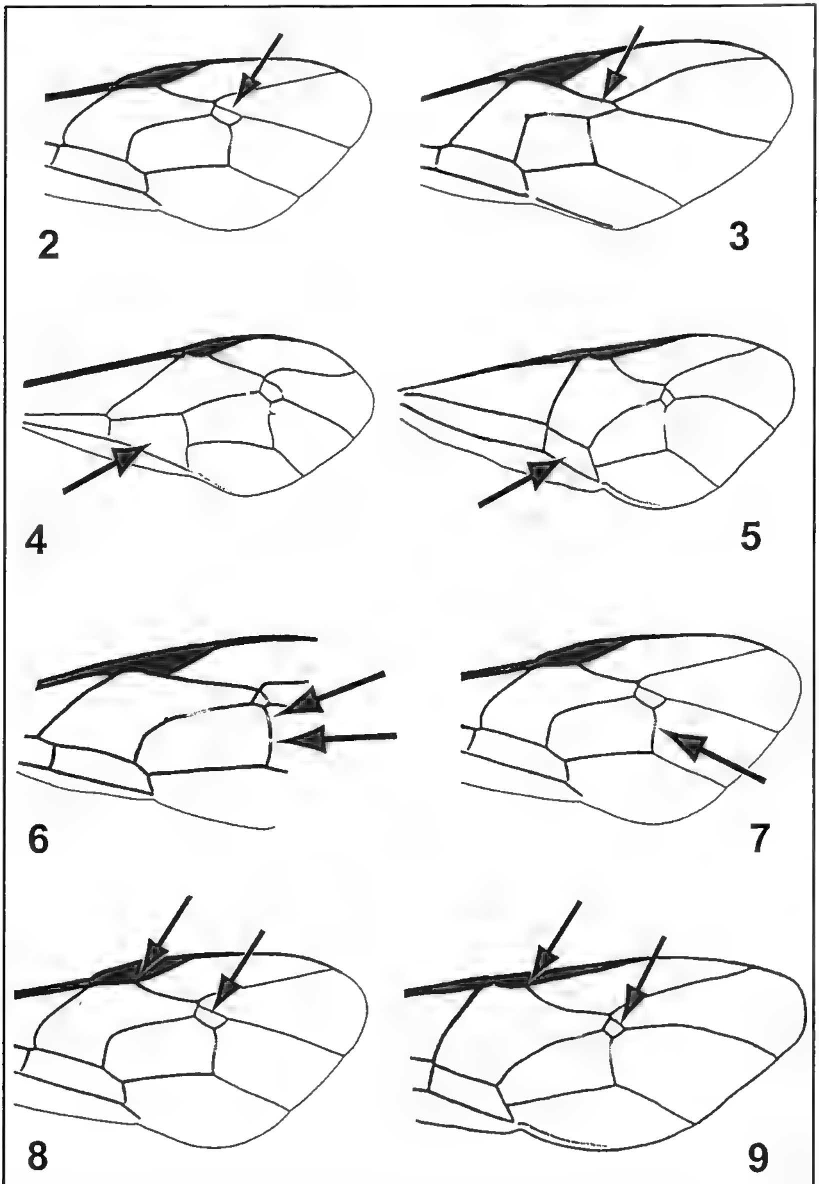
– First subdiscal cell of forewing about same height at each end (Fig. 5) ... 3

3 Forewing vein 2m-cu with two widely separated bullae (unpigmented portions of the vein crossed by flexion lines) (Fig. 6) .... *Netelia* Gray

– Forewing vein 2m-cu with a single long bulla (Fig. 7) 4

4 Areolet approximately rectangular, about twice as long as wide (Fig. 8, lower arrow); pterostigma (thickened vein about halfway along anterior margin of forewing) moderately broad, r-rs vein arising near its centre (Fig. 8, upper arrow) .... *Cidaphus* Förster

– Areolet diamond-shaped (Fig. 9, lower arrow); pterostigma long and narrow, r-rs vein arising near its proximal end (Fig. 9, upper arrow) .... *Hypopheltes* Cushman



Figs 2–9. Venation of the distal portions of the forewings of large nocturnal ichneumonids, encompassing the genera *Megaceria* (Fig. 4), *Netelia* (Fig. 6), *Cidaphus* (Fig. 8) and *Hypopheltes* (Fig. 9). Venation typical of species belonging to the Ophioninae is shown in Fig. 3. Arrows indicate locations of features mentioned in the key. Compiled from Gauld (1984).

Summary of light trap catches

The study site was an experimental planting of 500 eucalypts located near Hall, ACT (35°09'55.7"S, 149°02'49.9"E; altitude 615 m a.s.l.). The two light traps used were custom made so that they could sub-sample in seven periods from 1800 to 0600 h (illustrated in Steinbauer 2003).

We did not develop the above key until after our trapping was complete. Consequently, the following findings relate to large nocturnal ichneumonids as a whole rather than individual genera or species. Our light trapping yielded a total of 625 large nocturnal wasps. Based on a small sub-sample, we estimate that approximately 75% of the wasps were species of *Netelia* and the remainder Ophioninae.

The number of wasps caught fluctuated considerably from night to night but there was a clear downward trend in numbers from December to May (Fig. 10; see also Steinbauer *et al.* 2001, p. 530). The numbers of wasps caught showed a clear peak between 2130 and 0245 h, with 73.6% of them being caught in this period (Fig. 11). The phase of the moon also appears to have influenced the number of wasps collected, with more caught near the new moon than near the full moon (Fig. 12).

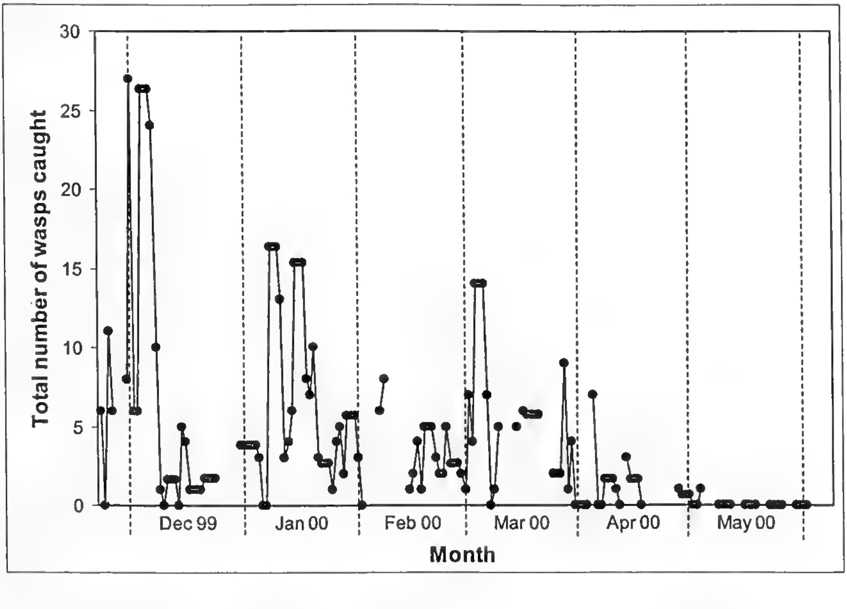


Fig. 10. Total number of large nocturnal wasps caught in light traps versus day of year (n = 625 individuals).

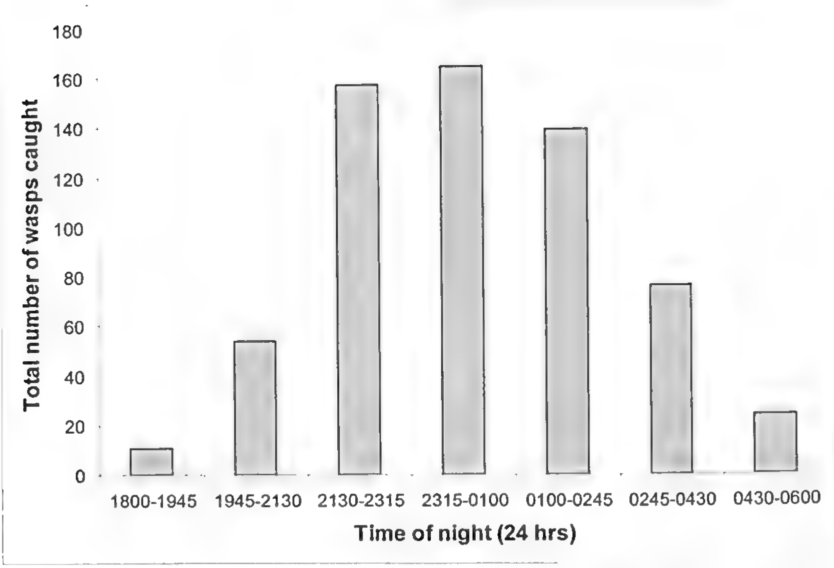


Fig. 11. Total number of large nocturnal wasps caught in light traps versus time of night ($n = 625$ individuals).

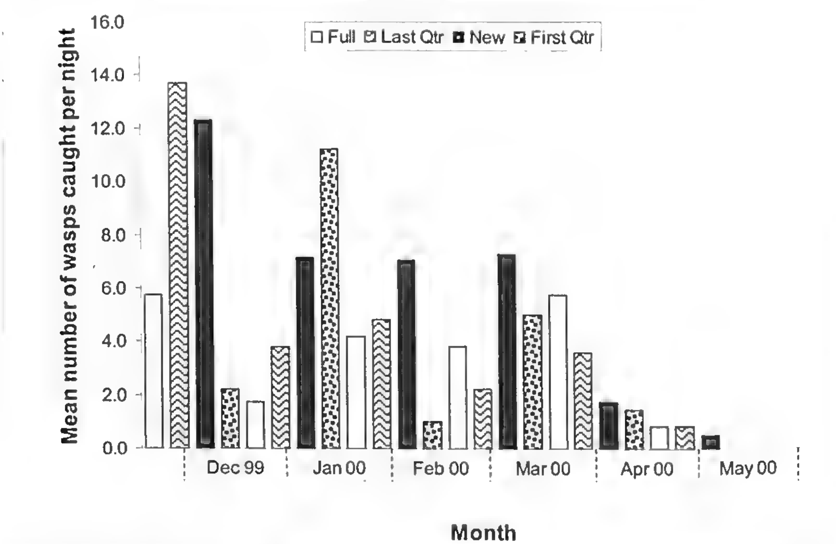


Fig. 12. Average number of large nocturnal wasps caught in light traps versus phase of moon (average computed for phase ± 2 nights).

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